Aviation English in South African Airspace

by

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Declaration

By submitting this thesis, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Salome Coertze
February 2013

Abstract

A lack of English proficiency and failure to use standard phraseology played a role in two of the world's largest aviation disasters in South Germany and Tenerife, respectively. As a result, the crucial role of effective pilot-ATC (air traffic controller) communication came under scrutiny and measures were put in place to ensure that aviation safety is not jeopardised by language-related problems. For example, the International Civil Aviation Organisation (ICAO) implemented English language proficiency standards and testing. The study reported in this thesis investigated the use of Aviation English and standard phraseology, which is used in radiotelephony communication by the operational aviation community. Aviation English consists of a range of operationally-relevant language functions and dialogue management, e.g. orders, requests, and offers to act; a blend of formulaic standard phraseology and plain or everyday speech if and when a non-routine situation occurs. Data on pilots' and ATCs' perceptions of the role of language in air traffic communication, their perspectives on English as lingua franca in aviation, and English language proficiency standards and testing were collected by means of a questionnaire. The respondents included full-time professional pilots (domestic and international flights), part-time professional pilots and pilots who fly for leisure, and ATCs in Air Traffic Navigation Service units that handle domestic and/or international flights. Recordings of on-site air traffic communication from two airport towers were obtained and were used to study the use of Aviation English and standard phraseology in pilot-ATC communication in South Africa. The results indicated that the majority of pilots and ATCs believe that language-related problems can cause fatal accidents and serious incidents. Pilots and ATCs in South Africa do experience threatening and potentially hazardous situations as a result of communication problems, however, they are confident that communication problems are resolved quickly and successfully in order to avoid accidents. The analysis of the voice recordings correlated with the pilots' and ATCs' perceptions that in spite of communication problems (language-related and non-language-related) occurring in South African airspace, pilots and ATCs have strategies in place to resolve them effectively and they are also able to use plain English to negotiate understanding and meaning. The majority of the respondents indicated that they agree that English should be used as the lingua

franca in aviation around the world and they regard the English language proficiency of South African pilots and ATCs as satisfactory. The majority support ICAO's English language proficiency standards and testing. The recordings presented a small percentage of transmissions with read-back/hear-back errors, but a substantial number of instances of radio distortions and background noise which interfered with the intelligibility of the transmissions, correlated with the results of the questionnaire. A small percentage of transmissions contained deviations from Aviation English and standard phraseology and/or the use of plain English. The researcher is of the opinion that this initial investigation into Aviation English serves to indicate some avenues for fruitful linguistic investigations into Aviation English and pilot-ATC communication in South Africa.

Opsomming

Ontoereikende taalvaardigheid in Engels en nalating om standaard frases te gebruik, het bygedra tot twee van die ernstigste vliegongelukke in lugvaartgeskiedenis, naamlik in Suid-Duitsland en Tenerife, onderskeidelik. As gevolg van die ongelukke, het die kritieke rol van effektiewe kommunikasie tussen vlieëniers en lugverkeerleiers onder die loep gekom, en maatreëls is ingestel om te verseker dat lugvaartveiligheid nie deur taalverwante probleme benadeel word nie. Die Internasionale Burgerlugvaartorganisasie (IBLO) het byvoorbeeld, onder andere, taalvaardigheidsstandaarde en -toetsing vir vlieëniers en lugverkeerleiers ingestel. Die studie in hierdie tesis ondersoek die gebruik van Lugvaart-Engels ("Aviation English") en standaard frases wat in radiokommunikasie deur die operasionele lugvaartgemeenskap gebruik word. Lugvaart-Engels bestaan uit 'n reeks operasioneel-toepaslike taalfunksies en gespreksbestuurmiddels, bv. instruksies, versoeke en ander handelinge; 'n mengsel van formele standaard frases *en* alledaagse Engels vir gevalle waar buitengewone of nie-roetine situasies hulle voordoen. 'n Vraelys is gebruik om inligting oor vlieëniers en lugverkeerleiers se sienings van die rol van taal in lugverkeerleiding in te samel, asook sienings oor die gebruik van Engels as *lingua franca* in lugverkeer en die IBLO se taalvaardigheidsstandaarde en toetsing vir vlieëniers en lugverkeerleiers. Die deelnemers sluit vlieëniers (voltyds en deeltyds, asook private en beroepsvlieëniers) in en lugverkeerleiers in lugverkeernavigasie-eenhede wat binnelandse en internasionale verkeer hanteer. Lewendige opnames wat van twee lughawetorings bekom is, is gebruik om taalverwante en ander kommunikasieprobleme tussen vlieëniers en lugverkeerleiers te ondersoek. Die resultate dui daarop dat die meerderheid vlieëniers en lugverkeerleiers van mening is dat taalverwante probleme tot noodlottige ongelukke en ernstige insidente kan lei. Daar is verder deur die deelnemers bevestig dat hulle dikwels in gevaarlike situasies beland waar kommunikasieprobleme tot die gevaar bygedra het, maar hulle is van mening dat kommunikasieprobleme in die Suid-Afrikaanse lugruim tydig en effektief opgelos word om ongelukke te vermy. Die opnames het met die bevindings van die vraelys ooreengestem en het aangedui dat, ten spyte van kommunikasieprobleme (taalverwant en nie-taalverwant) in die Suid-Afrikaanse lugruim, vlieëniers en

lugverkeerleiers oor die vermoë beskik om sodanige probleme vinnig en suksesvol op te los. Dit het ook aan die lig gekom dat vlieëniers en lugverkeerleiers in Suid-Afrika daartoe in staat is om in alledaagse Engels te kommunikeer om enige onduidelikheid of buitengewone versoeke en instruksies te hanteer. Die meeste van die deelnemers meen dat vlieëniers en lugverkeerleiers in Suid-Afrika se taalvaardigheid in Engels bevredigend is en taalvaardigheidstandaarde en -toetsing word sterk ondersteun. Die lewendige opnames het ’n klein persentasie terugleesfoute bevat, maar ’n groot aantal gevalle van radiosteurings en agtergrondgeraas het met die hoorbaarheid en verstaanbaarheid van die kommunikasie ingemeng, wat met die resultate van die vraelys ooreengestem het. ’n Klein persentasie van die uitsendings het afwykings van Lugvaart-Engels en standaard frases en/of die gebruik van alledaagse Engels bevat. Die navorser is van mening dat hierdie studie die weg baan vir potensiële navorsing binne linguistiek ten opsigte van Lugvaart-Engels en die kommunikasie tussen vlieëniers en lugverkeerleiers in Suid-Afrika.

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To all the pilots and ATCs in South Africa:
I wish you countless hours of safe flying and air traffic control with language and technology in total harmony. I hope to inspire many people in South Africa to join hands with Steven Cushing who believes it is not enough for wise men to study human nature and truth, but they should dare state truth for the benefit of those who are willing and able to think.
(Cushing, 1997: ix)

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List of abbreviations

ATC	Air Traffic Controller
ATNS	Air Traffic Navigation Services
CSIR	Council for Scientific and Industrial Research
ELF	English Lingua Franca
E-L1	English as first language
E-L2	English as second language
EFPS	Electronic Flight Progress Strip
ESP	English for Specific Purposes
FPS	Flight Progress Strip
ICAO	International Civil Aviation Organisation
L1	First language (home language/mother tongue)
L2	Second language
LPR	Language Proficiency Rating
QNH	Part of the Q code, which was used in the days of telegraphy as a rudimentary lingua franca. There are Q codes for most standard phrases in aviation and shipping.
SACAR	South African Civil Aviation Regulation
SACAA	South African Civil Aviation Authority

Chapter 1: Introduction

The study reported in this thesis set out to investigate the use of English as lingua franca in air traffic control in a context in which many air traffic controllers (ATCs) and pilots are non-native English speakers. The study specifically focuses on the use and nature of Aviation English in ATC-pilot communication. In this chapter, some background is provided before moving on to the research questions, and, finally, the chapter layout of the thesis.

1.1 Contextual overview

1.1.1 Influential aviation disasters related to language

Since 1951, English has been the international aviation language and therefore the lingua franca in airspace in most parts of the world – other languages in airspace include Spanish, French, Russian and Arabic. After a fatal collision in mid-air over Southern Germany, the issue of radio communication with regard to aviation safety came to the forefront. The two aircraft in this incident were under the orders of Swiss ATCs at Zurich and the controllers indicated that they had asked the Russian pilot to reduce his altitude, but that he did not respond at first. “The requests would have been in English and it is possible that a language problem caused a misunderstanding” (Hamer, 2002: 1).

However, it was the accident in Tenerife that created a vivid interest in language-related issues in aviation. The Tenerife Information Centre in the Canary Islands confirmed that radio communications difficulties can contribute to dangerous situations in aviation as it caused one of the worst accidents in aviation history (Tenerife Information Centre, 2009).

A lack of English proficiency and failure to use standard phraseology played a role in the world’s largest aviation disaster in Tenerife in 1977. Two Boeing 747 passenger aircraft (KLM and Pan Am, respectively) collided on the runway at Tenerife North Airport (formerly known as Los Rodeos Airport) on the Spanish island of Tenerife in

the Canary Islands. The crash, with 583 fatalities, is the deadliest accident in aviation history. According to Kirk (2012: 1), a major factor that contributed to the accident, was communication failure using the English language.

After a bomb explosion at Gran Canaria Airport resulting in the airport being temporarily closed, many planes had been diverted to Tenerife with the result that ATCs were forced to park many planes on the taxiway, thereby blocking it. Dense fog further complicated the situation and greatly reduced visibility for airline crews and ATCs. After Gran Canaria had been reopened, the two Boeings were required to taxi on the runway in order to get into position for take-off. However, the fog prevented them from seeing each other and the controller in the tower could not see the runway or the two planes on it.

Without ground radar the only means to identify the location of each aircraft was through voice communication over the radio[1]. The ensuing communication contained several misunderstandings and the KLM pilot, under the impression that he was cleared, attempted to take off with the Pan Am plane still on the runway. The collision destroyed both aircraft, killing all 248 people aboard the KLM flight and 335 of the 396 people on the Pan Am flight (Tenerife Information Centre, 2009).

In the investigation by the Spanish Ministry of Transport and Communications, one of the reasons for the disaster that was named, was a misunderstanding of the phrase *at takeoff* used by a flight crew member on the KLM aeroplane indicating that they were in the process of taking off. However, the ATC understood it to mean *at the takeoff point* and that they were waiting for final clearance to take off (Cushing, 1997: xiii).

[1] In aviation, a ground radar antenna sends out radio signal pulses that are reflected by aircraft on the ground. The radar scope displays the direction and distance from which the signals are reflected and, coupled with each aircraft's transponder signal, it identifies the aircraft on the radarscope (http://www.pilotfriend.com/training/flight_training/communication/radar.htm).

1.1.2 Resulting changes to regulations

One major consequence of the accident was that measures were put in place to ensure that aviation safety is not jeopardised by language-related problems in pilot-ATC communications. National safety boards started to penalise pilots for disobeying ATCs' orders, colloquial phrases like *Okay* were abandoned, and instructions by ATCs required read-backs of all clearances to ensure mutual understanding (Tenerife Information Centre, 2009). Although the International Civil Aviation Organisation (ICAO) implemented English as the international language in aviation in 1955 to improve "consistency in the accuracy and effectiveness of communication in pilot-ATC transmissions" and achieve standards with the view of eliminating communication problems, "language and comprehension difficulties have continued to be cited as a primary cause of operational airspace incidents" (Tiewtrakul and Fletcher, 2010: 229-230).

1.1.3 ICAO and English language proficiency standards

As of March 2008, ICAO subsequently implemented an Aviation English proficiency scale ranging from level 1 to level 6, and all pilots flying internationally and ATC personnel in international traffic control service centres must be proficient at level 4 or above – level 4 being the minimum "operational" level (Tiewtrakul and Fletcher, 2010: 229-230). ICAO clearly stipulates that all ATCs and pilots engaged in or in contact with international flights must be proficient in the English language as a general spoken medium and that they should not simply have a proficiency in standard ICAO radiotelephony phraseology.[2] English as a lingua franca, as well as Aviation English and standard phraseology for pilots and ATCs are discussed in Chapter 2.

The South African Civil Aviation Regulation (SACAR) 61.01.7, in compliance with ICAO regulations, clearly states: "In accordance with the requirements, Pilots and Air Traffic Service Personnel shall demonstrate a minimum proficiency of at least

[2] All references with regard to language proficiency requirements, standards and testing are taken from the SACAR and specifically CAR 61.01.7 *Language* (SACAA, 2008), in compliance with ICAO's Document 9835, Chapter 6 (ICAO, 2004).

Operational Level '4'[3] of both ICAO Standard Phraseology and plain language, to be issued with or to maintain their respective licenses." (researcher's emphasis) (South African Civil Aviation Authority (henceforth, "SACAA"), 2008). In situations where the use of only Aviation English and standard phraseology fail the speakers in understanding each other, both pilot and ATC must be able to communicate successfully in "non-technical" English in an effort to repair the breakdown in communication. The use of plain English will thus ensure that both parties understand what is happening at that moment. In the researcher's opinion, it is very important that non-native English speakers are able to distinguish between the appropriate and non-appropriate use of plain English in addition to or in lieu of Aviation English if and when necessary. The ability to distinguish is only possible if there is communicative proficiency in both plain and Aviation English, the latter in tandem with the required standard phraseology.

If flight crew members and ATCs do not comply with the abovementioned requirement, new licenses are not issued and existing licenses are not renewed, with serious consequences for both pilots and ATCs in full-time jobs, especially in an international traffic environment. Tiewtrakul and Fletcher (2010) found that problems in aviation transmissions are most commonly reported "in relation to messages containing non-standard phraseology". Tiewtrakul and Fletcher also cited an observation by Tajima (2004) that insufficient English skills of non-native English speakers is not the only source of error or misunderstandings, and that the use of colloquial and ambiguous English by native English speakers definitely also plays an important role in miscommunications and situation awareness. Some examples are given below:

- A misunderstanding of the verb *hold*, which is supposed to mean *stop what you are doing* in standard aviation speak, but can mean *continue what you are doing* in idiomatic conversational English, partly caused the accident at John Wayne Orange County Airport in Santa Ana in California in 1981.
- A misunderstanding of the reference of the word *things* which was meant by the ATC to refer to the aircraft's reducing altitude, but understood by the crew to refer

[3] The levels of ICAO's language proficiency ratings and testing procedures are discussed in detail in Chapter 2.

to a nose-gear problem they were preoccupied with, partly caused the accident at Miami International Airport in 1972.

- The use of the non-technical English phrase *running out of fuel* by a co-pilot, rather than the technical aviation term *emergency* to convey the intended degree of urgency to the ATC, partly contributed to the accident at Cove Neck in New York in 1990. (Cushing, 1997: 1-2)

1.1.4 Some influential studies on pilot-ATC communication

Two previous studies on the communicative difficulties that occur among pilots and ATCs are briefly discussed before turning to the objectives and research questions of the study reported in this thesis. In the first, Tiewtrakul and Fletcher (2010) studied difficulties in understanding in ATC-pilot communications where regional accents in Bedfordshire, in the United Kingdom, pose a challenge for understanding Aviation English when the parties have significantly different accents. The fact that ICAO acknowledged a continued problem of language in aviation in spite of the standard international use of English, and because they ascribed some of the problems to the influence of different accents, this study aimed to investigate the notion that even the standardisation of terminology can sometimes not overcome the hurdles of accents and local language idiosyncrasies. These difficulties are often enhanced by cultural interpretations and the usage of culture specific terms, especially in stressful situations.

Tiewtrakul and Fletcher's (2010) study entailed a detailed analysis of the voice transmissions of 312 international flights recorded at Bangkok International Airport in Thailand. The transmissions comprised three groups to represent the different degrees to which non-native English speakers use English as the shared language, namely 104 Thai ATC-Thai pilot (same native language but distinctly different from English), 104 Thai ATC-native English speaker pilot (non-native English speakers and English speakers), and 104 Thai ATC-foreign pilot (non-native English group). The flight conversations, which involved ATCs issuing an instruction, clearance or request and required the pilot to read back or answer to confirm understanding, were transcribed and examined using a conversation analysis (CA) technique. The

technique was applied to interpret and categorise instances where a pilot was considered to either “understand” or “not understand” the verbal messages.

The results of the study showed that certain words and facets of language and accent can indeed cause problems in understanding messages between ATCs and pilots, and the researchers suggested that although not always possible, techniques like stress, intonation and pause could be developed in order to alleviate the problems. The results highlighted the significance of the non-native English accent in radio transmissions between pilots and ATCs that cross culture and language.

The researchers strongly suggest that further studies should include various facilities across different countries to provide a better appreciation of cultural, regional and linguistic differences in English language use among pilots and ATCs in order to identify particular areas of concern (Tiewtrakul and Fletcher, 2010: 231).

The other study discussed here was conducted by Sullivan and Girginer (2002) after one of the authors found herself in a situation where she was asked to teach English to future pilots and ATCs in Turkey, and although she was an English teacher, she had little knowledge of the English language needs of this particular group of students. She subsequently documented actual language (standard discourse transactions) used by pilots and ATCs at work to increase her awareness of and to become more familiar with the needs of the students.

The primary data of unrehearsed and unplanned discourse was collected at the Ataturk International Airport in Istanbul and during the study local variations in language use were also analysed. Transcriptions of the discourse were made and the researcher conducted interviews with Turkish ATCs and pilots to cross-check the data. Approximately nine hours of recordings were used, 25 pilots and 25 ATCs at Ataturk International Airport completed the questionnaires, and interviews were conducted with 10 Turkish pilots and 10 Turkish ATCs. At this airport, all the ATCs are Turkish, but the pilots present in this set of data were from many different countries. However, more than half of the pilots at the time worked for airlines in Turkey, others were from Germany and West Asia, and only two pilots represented

countries in which English is a majority native language, namely the USA and England.

Firstly, the collection of on-site data turned out to be a rich resource for materials development for English for Specific Purposes (ESP) teachers and secondly, the results showed that although ICAO specifies the rules for Aviation English and monitors the language, variations in local use were present. The researchers identified a need to "develop vocabulary and conversational English skills for the non-native speakers of English" (in this case native Turkish speakers) for use in the professional aviation setting (Sullivan and Girginer, 2002).

1.2 Objectives and research questions

The research reported in this thesis was conducted in South Africa; the aims and research questions that steered this project (see below) are thus formulated for the South African context.

1.2.1 Objective 1

To investigate pilots' and ATCs' perceptions of the role of language in air traffic communication.

Research questions

1. Do pilots and ATCs believe that language-related problems can cause fatal accidents and serious incidents?
2. Do pilots and ATCs experience threatening (dangerous) situations where communication problems contributed to the situation?
3. How confident are pilots and ATCs that problems in communication among pilots and ATCs are resolved quickly and successfully in order to avoid accidents?

1.2.2 Objective 2

To investigate pilots' and ATCs' perspectives on English as lingua franca in aviation, and on English language proficiency standards and testing for pilots and ATCs.

Research questions

1. Do pilots and ATCs agree with the use of English as the lingua franca in international aviation?
2. Do pilots and ATCs support English language proficiency standards and testing for their professions?
3. How do pilots and ATCs rate the average level of current English language proficiency in air traffic communication in South Africa?

1.2.3 Objective 3

To investigate the use of Aviation English in air traffic control communication in South Africa.

Research questions

1. What are the elements that cause problems and possible misunderstandings or miscommunication between pilots and ATCs?
2. When deviations from Aviation English occur and misunderstandings or communication breakdowns happen, are such instances quickly and effectively repaired?

In order to address the research questions related to Objectives 1 and 2, the researcher followed a qualitative approach and collected data from pilots and ATCs, which included full-time professional pilots (domestic and international flights), part-time professional pilots and pilots who fly for leisure, and ATCs in air traffic service units that handle domestic and/or international flights. Participants were asked to complete a questionnaire that was designed to determine pilots' and ATCs' perceptions of the role of language in air traffic communications, English as lingua franca, and English language proficiency standards and testing. The questionnaire

was posted on the Internet so that respondents could easily complete it by simply clicking the appropriate options in a multiple choice format.

In order to address the research questions related to Objective 3, the researcher obtained recordings of approximately 10 hours of on-site air traffic communication. The recordings were used to study the use of Aviation English in pilot-ATC communication, to determine if pilots and ATCs deviate from Aviation English and the effect thereof, and to determine whether any breakdowns in communication are quickly and successfully resolved. An aviation expert was consulted in designing the questionnaire and in analysing the recordings.

A pragmatic approach to the recordings was followed where the focus is mainly on problems of interaction that occur in contexts where successful communication is critical, e.g. doctor-patient discourse in medical interviews, judicial settings, counselling speech events, and air traffic communication between pilots and ATCs – the latter added to the list by the researcher.

Another motivation to conduct this study developed from studies on speech systems for unmanned aircraft within a cognitive discourse analysis framework.

Cognitive discourse analysis is influenced by cognitive science, i.e. cognitive psychology, cognitive linguistics, and artificial intelligence, where the latter involves an effort to make machines do tasks which are normally seen as requiring intelligence from two different perspectives. The first perspective is the engineering approach and the second perspective is the cognitive science approach. The main difference in the two approaches is the criteria for success, and while the engineering perspective wants solutions that try and mimic with machines what we know about humans, or ultimately outperform human skills, the cognitive science approach tries to design solutions from scratch and then see how well they fit what we know about humans (Malmkjær, 2002: 114-119).

This study on the analysis of speech between pilots in aircrafts and ATCs could be pertinent to the development of speech systems for unmanned aircraft. Burger, Barnard and Jones (2011: 1) wrote that “ICAO regulatory guidelines make no

distinction between unmanned aircraft and manned aircraft, implying that unmanned aircraft will have to comply with requirements for radio communication in certain airspaces". Therefore, speech capability is imperative and must be available for autonomous operations in civil airspace traffic including both speech synthesis and speech recognition to support two-way communication. In developing such systems, one of the tasks would be to evaluate the performance of the system against a range of targets, i.e. from baseline capabilities to more advanced real-life scenarios, and the performance must be compared with that of a human pilot. While many people may assume that such unmanned aircraft operations must be error-free, such performance levels are not necessary in practice. The reason is that aviation systems are designed with the knowledge of frequent human errors and they include redundancy to alleviate the effects of such errors; human pilot operations are not error-free and frequent requests for clarification or correction are found in such speech events.

Therefore, an aircraft speech system needs to meet human performance levels. Burger, Barnard and Jones (2011: 3) pointed out that work on measuring error rates in pilot-ATC communication needs to be extended in order to provide a local measure of error for the development of a benchmark that can be used as a design and an accepted standard system for the local environment in South Africa. This study is one such effort to use well established methodologies and apply them to pilot-ATC communications to establish target error rates, e.g. the methodology used by the John A. Volpe National Transportation Systems Center, which is discussed in detail in Chapter 2.

1.3 Outline of the thesis

This thesis consists of five chapters, including this one. Chapter 2 contains a broad literature review on English as lingua franca and Aviation English, including standard phraseology to contextualise the research. Chapter 3 provides details on the research methodology and design, describing the respondents and the data collection instruments that were employed. The results of the research, with reference to the three objectives stated above, are reported and discussed in

Chapter 4. Chapter 5 concludes the thesis with a brief discussion of the implications of the results for safety in aviation in the South African context, suggestions for future research, and a brief discussion of the limitations and strengths of the research project. Before turning to the literature review in Chapter 2, a list of core terms is provided below.

List of core terms

Aircraft call-sign	A unique identifier used for a specific aircraft in flight. For General Aviation aircraft, the aircraft registration is most often used. In South Africa, this registration consists of five letters, normally abbreviated to three on the radio (ZS-MUS becomes Mike Uniform Sierra).
Aviation English	Aviation English is essentially oral and communicative because it entails discourse between pilots and ATCs by means of radio transmissions. A very specific and varied lexical corpus is employed by the operational aviation community, which includes weather, mechanics, aerodynamics, security, health, geography, human behaviour, navigation, airport infrastructure, and others. A range of operationally-relevant language functions and dialogue management is present in Aviation English, e.g. orders, requests, and offers to act. Aviation English is used in radiotelephony communication - a blend of formulaic standard phraseology and common or natural speech if and when a non-routine situation occurs.
Flight Progress Strip (FPS)	A tool used by ATCs in air traffic control to keep track of details of and instructions to aircraft. In some cases electronic flight progress strips (EFPS) and data blocks are displayed on a computer screen.
Hear-back	A conscious effort by an ATC to verify that the pilot repeated the instruction(s) correctly while reading back.

Lingua franca	An auxiliary language that is used to enable routine communication between groups of people with different native languages.
Radiotelephony communication	Communication between pilots and ATCs by means of radio transmission and according to rules and guidelines provided by aviation authorities.
Read-back	A pilot's acknowledgement of an ATC's transmission. All clearances are read back verbatim and information is acknowledged.

Chapter 2: Literature Review

2.1 Introduction

As explained in Chapter 1, the study reported in this thesis has three objectives:

- **Objective 1:** To investigate pilots' and ATCs' perspectives on the role of language in air traffic communication.
- **Objective 2:** To investigate pilots' and ATCs' perspectives on the use of English as a lingua franca (ELF) in air traffic control in South Africa (including the accompanying language proficiency standards and testing).
- **Objective 3:** To investigate the use of Aviation English in South African air traffic control.

In order to provide a framework for the study, relevant literature on the two central domains is discussed in this chapter:

(i) ELF in a multilingual world and, more specifically, in South Africa, and
(ii) Aviation English.

The discussion of Aviation English includes an outline of the English language proficiency ratings (LPRs) required by ICAO for pilots and ATCs; standard phraseology used in Aviation English; and the phenomenon of institutional talk. Finally, two recent studies on pilot-ATC communication (conducted in Belgium and the USA, respectively) are discussed, as they are highly relevant to the study reported in this thesis and offer a model for the analysis of pilot-ATC communication.

2.2 English as a lingua franca

2.2.1 Lingua franca

Crystal (1991: 203) defines “lingua franca” as a term that is used in sociolinguistics and in everyday speech in reference to an auxiliary language that is used to enable routine communication between groups of people with different native languages. Richards, Platt and Weber (1985: 166-167) add to the definition by saying that a lingua franca could be an internationally used language of communication, a native language of one of the groups of people, or a language which is not a native language to any of the groups but has a “simplified sentence structure and vocabulary and often a mixture of two or more languages.” The term “lingua franca”, which is Italian for “Frankish tongue”, originated in the Middle Ages in the Mediterranean region among crusaders and readers who had different language backgrounds.

According to Crystal (1991: 203), English is the world’s most common lingua franca, followed by French, but other languages are widely used in certain contexts, such as Swahili in East Africa, and Hausa in West Africa.

2.2.2 English as lingua franca (ELF)

Onraët (2011: 1) writes that “in the global context, non-first language (non-L1) English speakers outnumber first language English (E-L1) speakers”. She notes that English has become the most widely used language for, amongst other things, trade, politics, education, and academia. Crystal (cited in Onraët, 2011: 11) states that there are more or less 400 million E-L1 speakers, 600 million E-L2 speakers and 600 million foreign-language speakers of English in the world. It is the main language of books, newspapers, airports and air traffic control, international business and academic conferences, science, technology, medicine, diplomacy, sports, and international competitions, as well as the most widely-used language on the Internet (Onraët, 2011: 11).

According to Malmkjær (2002: 536), ELF "is the main contender for the position of world lingua franca." She states that many factors contribute to the gradual spread of a language, namely political and military power, economic power and religious influences. Onraët (2011: 11) explains that English became "the language of the world" not due to any superiority of linguistic features, but because of the political, economic and military success England enjoyed at a critical time in history. However, for these same reasons, the development of a world language may not be accepted with enthusiasm by all who have to learn it. Furthermore, as a language is used in all corners of the world and in all walks of life, it develops new spoken varieties used by local people as symbols of their identity. Malmkjær (2002: 539) finds it ironic that the growth of a language is - because of the forming of these varieties - endangered from within the language itself and notes that how far diversification will affect English as a lingua franca will be interesting to observe over time.

Canagarajah (2007: 923-924) presents recent research related to ELF and describes it as "radically reconfiguring the new models of language usage and acquisition being constructed in the field of linguistics and specifically in second language acquisition". Canagarajah is of the opinion that globalisation, multilingual contact and ELF serve as an impetus for the continued disciplinary rethinking regarding language use and acquisition and the way we address language processes and practices.

Graddol (1999) predicted in 1999 that English would become a language used mainly as a second language in multilingual contexts and for communication between groups of non-native English speakers. According to Canagarajah (2007: 925), this prophecy has already been realised. English is very often used by speakers of other languages as a contact language in new contexts of transnational communication. "Speakers of English as an additional language are greater in number than the traditionally understood NSs[4] of English who use English as their sole or primary language of communication."

[4] "NSs" refers to native speakers. Many multilingual speakers claim NS status in English (Canagarajah, 2007: 937).

Canagarajah (2007: 925) argues that we need to understand the character of ELF – "a variety that overshadows national dialects", dominant ones such as British English and American English, as well as the recent nativised forms of Indian English and Singaporean English.

According to Canagarajah (2007: 925), one of the characteristics of ELF is that it belongs to a virtual speech community due to the fact that the speakers of the language are not located in one geographical area. ELF speakers inhabit and practise other languages and cultures in their different immediate localities; therefore, what is at issue is a linguistic-cultural heterogeneity and spatial disconnect in which ELF serves as a shared resource. Non-native speakers of English activate mutually recognised attitudes, forms and conventions to ensure successful communication when they are interacting with each other.

Although it is unclear what exactly constitutes the threshold level of English proficiency in this ELF community, it is evident that some level of proficiency is certainly necessary and even individuals with a rudimentary knowledge of English can successfully communicate while developing their proficiency further. Multilingualism is the core element of the ELF hybrid community identity and speaker proficiency, and ELF speakers and native English speakers have competence in their respective varieties. There is no limit to the development in proficiency through experience and time, subject of course, to the effect of age at the onset of exposure, as noted in a wealth of adult L2 acquisition research. ELF is inter-subjectively constructed in a specific context of interaction and the form of this English is negotiated by each set of speakers for their purposes – a direct result of the diversity at the heart of a shared language in a multilingual context.

Speakers belonging to the same ELF "community" are able to monitor each other's language proficiency to determine the appropriate grammar, phonology, lexical range and pragmatic conventions that would lead to intelligibility. ELF cannot be characterised outside the specific interaction and speakers in a communicative context; here Canagarajah calls on Meierkord (2004) who states that ELF "emerges out of and through interaction and for that reason it might well be that ELF never achieves a stable or even standardised form".

ELF is variable in form because the type of language is negotiated by the participants and what is inappropriate or unintelligible in one interaction might be appropriate and intelligible in another. ELF's form is hybrid in nature. Speakers bring to the interaction words, grammatical patterns and discourse conventions from a number of diverse languages and English varieties.

Onraët (2011) provides a valuable overview of the work of scholars who contributed much towards establishing ELF as an important study field in an increasingly multilingual environment globally. Some of the findings that she discusses regarding the features of ELF are pertinent to this study and are therefore briefly presented below.

2.2.2.1 Communicative features of ELF

House (2002: 251), after analysing authentic ELF interaction in semi-structured, face-to-face interaction between speakers of different nationalities, described the communicative features of ELF as including an overwhelming presence of the "let it pass" factor, which occurs when a speaker produces an utterance that is difficult for the hearer to understand. In ELF interaction, it seems to be the rule rather than the exception for a hearer not to try and sort out a misunderstanding but to rather let the utterance pass in the hope that the misunderstanding will be resolved as the conversation progresses. House argues that this phenomenon indicates "mutual dis-attention" of ELF interlocutors to mismatches in English proficiency, and even though they show each other that they are listening, they do not make the effort to show their understanding.

Interlocutors in ELF often do not think it is essential to adjust utterances to fit the conversational needs and expectations of their conversational partners – in other words, there is a lack of "accommodation" or a lack of communicative behaviour adjustment to fit the other party's needs and expectations.

House found hardly any use of discourse markers or discourse particles to facilitate oral communication. Speakers would repeat large parts of the other interlocutor's utterances to facilitate understanding and production and to provide textual

coherence, to request confirmation and to make it clear that the present speaker does not want to "steal" the other speaker's turn. ELF interlocutors often use conjunctions at the beginning of utterances. Words like *and* and *but* are used to supply a connection between the participants' utterances. Conjunctions are apparently used in an attempt to make up for failure to use more interpersonal devices to smooth turn changes.

Sometimes ELF interlocutors attempt to change the topic of conversation by producing irrelevant utterances, but in spite of lower levels of English proficiency, they do have a level of strategic competence which enables them to negotiate successfully, and they should not be regarded as inept speakers or as deficient in their English linguistic abilities when they diverge from the E-L1 speaker norms.

2.2.2.2 ELF and Standard English

Seidlhofer (2004: 209-239), using data from the VOICE[5] project, noted that the use of certain features in ELF which are regarded as errors in terms of Standard English, do not pose problems to the communicative process:

- Omission of the third-person singular morpheme *–s* in present tense.
- Interchangeable use of relative pronouns such as *who* and *which*.
- Omission of definite and indefinite articles where they should be used, e.g. *Are we going to see movie?*, and insertion in places which would be considered ungrammatical in Standard English, e.g. *He is putting on a sunglasses*.
- Incorrect tags in questions, e.g. *He should know better, no?* versus *He should know better, shouldn't he?*
- Redundant prepositions, e.g. *We have to read about.*
- Use of *that*-clauses in place of infinitive constructions like *We want that you….*
- Explicitness, e.g. *blue colour* versus just *blue.*

[5] VOICE is the acronym for the Vienna-Oxford International Corpus of English – an extensive corpus of primarily spoken English as it is used as a global lingua franca irrespective of the L1 and level of English proficiency of the speakers.

Seidlhofer (2004) further argues that a limited vocabulary and a deficiency in paraphrasing skills contribute to misunderstandings in ELF communication, and in cases when speakers use idiomatic speech (most likely E-L1 speakers), the hearer has difficulty understanding because he/she (i.e. the ELF speaker) is not familiar with certain idiomatic expressions.

2.2.2.3 Syntactic variations in ELF

Meierkord (2004: 109-132) analysed syntactic variations in ELF that were found in 22 hours of recorded natural conversations (including 49 speakers from different countries and with varying levels of ELF competency). Some interesting findings were that the syntactic features in the ELF interactions varied according to the interlocutor's linguistic background, and systematic features that had already been recognised in literature on E-L2 varieties were found in some of the ELF conversations, while in other ELF conversations a large number of less established features were present. Meierkord attributes the latter finding to L1 transfer at a lower level of competency or as a result of interlanguage patterns still in development. The notable syntactic differences manifested in simplification and regularisation. Simplification involves shorter causal or phrasal units to form basic informational units of interactions (Meierkord, 2004:126). Simplification was specifically used by more competent speakers to accommodate less competent speakers when they signal non-understanding or request clarifications. Regularisation, a common syntactic feature in the data Meierkord collected, was used by both very competent and less competent speakers. Regularisation becomes apparent when speakers make use of topicalisation – to move focussed information to the front of utterances, especially in the case of noun phrases, e.g. *You have to do <u>three years</u>* becomes *<u>Three years</u> you have to do*. Meierkord (2004:126) attributes the occurrences of topicalisation to speakers' attempts to make discourse processing easier by simplifying syntactic structures of ELF utterances.

2.2.2.4 Misunderstandings in ELF discourse

Mauranen (2006: 123-150) studied misunderstandings in ELF – how speakers signal and prevent them. She used recorded and transcribed data from the English as Lingua Franca in Academic settings (ELFA) corpus, specifically recordings of four different seminars and one conference discussion with participants of different language backgrounds. Three ways of signalling misunderstanding were identified: direct and specific questions directed at the speaker to understand the meanings of phrases; repetition of phrases by the hearer which is a less obvious, less bold and, therefore, more indirect way of indicating misunderstanding to the speaker; and an even more indirect way, i.e. some signalling by the hearer but in a very unspecific way with utterances like *yeah?*, *what*? and *yeah okay* (which provide no aid to the speaker for pinpointing the locus of confusion).

In terms of the prevention of misunderstandings, Mauranen found that the participants requested clarifications or confirmations; they reformulated phrases and also offered additional explanations. Confirmation checks were either minimal or more explicit, and comprehension checks and the following responses indicated that the participants in the conversations were willing to cooperate in establishing comprehension, fully aware of its precariousness.

Secondly, the interlocutors made use of interactive repairs to prevent misunderstandings. When a speaker had difficulty finding the right word or phrase, the hearer recognised the communicative problem and offered verbal contributions to assist. Most of these repairs had the aim to enable continuation of the conversation.

Lastly, speakers used a technique of self-repair, meaning that when they realised they had made an error with regard to content or grammar in their utterances, they repaired the error either immediately during the utterance or at the end of the utterance. An interesting observation Mauranen made was that E-L2/ELF speakers tend to self-repair their utterances (grammatically speaking) more often than E-L1 speakers do; E-L1 speakers tend to focus more on content and meaning rather than on grammar (even though they also regularly make grammatical errors in

spontaneous speech – referred to as so-called “performance errors” because they result from performance factors rather than deficiencies in competence). According to Onraët (2011: 30), Mauranen added that interactive repair and self-repair are efficient cooperative ways to enhance the flow of mutual intelligibility when ELF discourse takes place.

2.2.2.5 Code-switching in ELF communication

In Chapter 1 of this thesis, the researcher refers to a study on the communication between pilots and ATCs in Turkey where it was found that Turkish pilots and ATCs on some occasions code-switch to their L1 in radiotelephony communications. The researcher deems the phenomenon of code-switching important in the discussion of Aviation English and ELF in aviation, because it is not in accordance with ICAO’s regulations and it is, therefore, an obvious diversion from the English standard phraseology that should be used in pilot-ATC communication.

Klimpfinger (2007: 36-62) studied code-switching in ELF interactions. Twelve hours of recordings of interactions at a conference in Vienna in 2004 were analysed. Most of the participants had different European L1s and a few Asian L1s, and ELF had to be used at the conference. The participants were all competent in English due to the fact that they had learnt it in formal education and had many opportunities to practise ELF because of their involvement in an international committee. Suggested reasons for code-switching in single words, short phrases or longer turns are the following: code-switching provides a means to direct speech acts to one specific person rather than to the whole group; it is used to signal the need and reception of assistance from L1 speakers of the language; and it may help an ELF speaker to feel better equipped in expressing ideas. ELF speakers who frequently discuss highly specialised topics (e.g. when they engage in business talks or participate in academic conferences) would most likely be more proficient in their L1s– they use specific adjectives to indicate the language community they belong to (e.g. *my university or French*, etc.) and therefore reinforce the fact that they are representing that language community and not an L1 English community.

2.2.3 ELF in South Africa

Since this study focuses on English as the shared language in aviation in South Africa, it is worthwhile to briefly look at the distribution of English in this country. Over time, English has developed as an L2 for many people in South Africa, including the Afrikaans population, speakers of many different African languages, and people who immigrated from India to South Africa in the 1860s (Crystal, 2003: 43).

Since 1993, South Africa boasts 11 official languages, including English. Although there is a goal to strive for recognition for all these languages, "English will still function as an important lingua franca between speakers who do not share an L1". (Onraët, 2011: 12)

In South Africa, many people view English as the language of success and many parents prefer that their children are educated in English rather than in their mother tongue. This situation resulted in many South African varieties of English, e.g. Black South African English and Afrikaans English (Onraët, 2011: 12).

Onraët (2011: 13) states that the need for a lingua franca is clear because "no single language community in South Africa has an outright majority in terms of numbers of speakers" and because of the 11 official languages in South Africa which are members of five different language families with limited mutual intelligibility. By far the majority of South Africans do not speak English as their L1[6], but a considerable percentage of the population has this language as a second or even a third language. For this reason, English is used as a medium of communication between South Africans who do not share an L1 and it can indeed be regarded as a lingua franca. Furthermore, the number of highly proficient speakers of English is steadily increasing in South Africa (Onraët, 2011: 6-7).

[6] According to the 2001 census, only 8,2% of the South African population speak English as their mother tongue. Languages with more mother tongue speakers than English are isiZulu, the mother tongue of 23,7% the population, isiXhosa (17,6%), Afrikaans (13,3%) and Sepedi (9,4%) (Statistics South Africa 2003).

There is limited research on ELF in South Africa, but some studies have been conducted on the grammatical features of L2 varieties of English in the country. Many ELF features have been found to be typical of E-L2, but there is a difference in the approach to studying E-L2 versus ELF in that in E-L2 studies E-L1 is regarded as the target variety, whereas in ELF studies, the E-L1 norm is not regarded as the target for ELF speakers, and, consequently, differences between ELF and E-L1 are not regarded as errors or deviations. In other words, the goal in studying ELF is grounded not in a normative approach, but rather in a communicative approach, i.e. to achieve communicative aims in a multilingual context (De Klerk, 1996: 35).

Due to the fact that the study reported in this thesis focuses on ELF used in aviation specifically, a detailed explanation of the different varieties of ELF in South Africa and their grammatical features falls outside the scope of this thesis.

In conclusion, as mentioned before, since 1951 English is the lingua franca in aviation in most parts of the world, and South Africa, as a multilingual country, joins countries all over the world in complying with ICAO English language proficiency requirements and ratings. The main feature of English as a shared language in aviation is standard phraseology used in radiotelephony air traffic communication. The language that pilots and ATCs use, is often referred to as “Aviation English”.

The following section is devoted to ELF in aviation (i.e. Aviation English) and discusses the role of language in aviation safety (the human factor), ICAO’s English language proficiency requirements, ratings and testing procedures, and, lastly, the standard phraseology of Aviation English.

2.3 English as lingua franca in aviation

2.3.1 Introduction

In 1997, Cushing very aptly pointed out that “aviation safety is and will remain one of the central concerns of our time for anyone who lives on this planet.” (Cushing, 1997: ix) He further states that ignorance of the role of miscommunication in undermining

aviation safety is no longer an option. Reasons for communication problems in aviation vary a great deal and although not all of them are language-related, language-related communication problems can cause dangerous situations in which human life can be threatened.

Cushing (1997) discusses different communication problems in pilot-ATC communications, i.e. language-based communication problems, e.g. ambiguity, homophony, intonation, speech rate, problems of reference (uncertain reference, uncertain addresses), problems of inference (implicit inference, lexical inference, unfamiliar terminology and false assumptions), problems involving repetition (kinds of repetition, full and partial read-backs[7], repetition across languages, cognisance, engagement and ritualisation).

As far as non-language-based communication problems are concerned, Cushing mentions problems with numbers, problems with radios, and problems of compliance like distractions, fatigue, impatience, obstinacy and non-cooperation, frivolousness and crew conflict.

In conclusion, Cushing notes that there are other problems e.g. message sent but not heard, message not understood, and message not remembered (Cushing, 1997: ix-x).

Following Cushing's notions of communication problems in aviation, this study partially aims to place linguistic issues in a broader communication framework of real-life discourse between pilots and ATCs in an effort to investigate the relationship between language and aviation safety in South Africa and the nature of Aviation English and standard phraseology. Cushing (1997) presented data from audiotapes of pilot-ATC dialogues recorded at an airport in the USA, but also transcripts that were published in accident reports by the National Transportation Safety Board (NTSB) and the Aviation Safety Reporting System (ASRS) of the NASA-Ames Research Centre in the USA. Along the same lines, the study reported in this thesis

[7] A pilot's acknowledgement of the ATC's transmission to confirm comprehension and that the transmission was heard. Clearances are read back verbatim and information is acknowledged.

used recordings of real-life communications between pilots and ATCs at airport towers, obtained from Air Traffic Navigation Services (ATNS) in South Africa.

In order to successfully analyse pilot-ATC discourse, one needs to understand the phenomenon of Aviation English and therefore in this section three core topics related to Aviation English are discussed:

(i) language and aviation safety – the human factor;
(ii) the English Language Proficiency Requirements, Ratings and Testing in aviation according to the SACAR 61.01.7 of South Africa (SACAA, 2008) in compliance with ICAO Document 9835, Chapter 6 (ICAO, 2004); and
(iii) standard phraseology in radiotelephony communications.

2.3.2 Language and aviation safety – the human factor

The preferred means of communication among humans as well as between humans and machines is the voice because of its natural appeal and because most people find it the most convenient form of communication. Cushing argues that “language-related misunderstandings of various kinds”, a contributing factor with regard to aviation accidents and potential dangerous situations, are present because natural language is complex and flexible and therefore also problematic, evidently causing confusions and misunderstandings in human interactions (Cushing, 1997: 1-2).

Many occurrences of misunderstandings are the result of clashes between individual cognitive and social interactive factors of language use. The first refers to aspects of the communicative situation regarding internal mental states or processes of individual speakers or hearers including mental models of the world or specific situations, judgements of aspects of the world, assumed values or expectations, and individual beliefs. The second refers to aspects of the relation or interaction of two speakers or hearers including conventions of use, standardised definitions, official and prescribed protocols, and status in a hierarchy of authority. Although there are arguments over which factor is the most important in language, a consensus is developing that both the abovementioned factors are indispensable. As with meaningful human language in use, in general, communication between humans in

aviation thus involves a “complex interplay of both these sorts of factors”, and if the two sorts do not match in the ways they are supposed to, the consequences can be disastrous (Cushing, 1997: 2-3).

Two examples that represent fatal or near-fatal aviation incidents and near-incidents in which language aspects (misunderstandings, omissions or communication confusion) have contributed, or even played a central role, are briefly described below.

Monroe County Airport, Rochester, New York, USA (1978): The investigators identified the probable cause of the accident as “the captain’s complete lack of awareness of airspeed, vertical speed, and aircraft performance” and the “first officer’s failure to provide required callouts” that might have drawn the captain’s attention to the airspeed and sink rate deviations (Cushing, 1997: 3). The accident therefore was a result of the captain’s cognitive state and the fact that he was not made aware of the situation by his fellow crew member. The first officer’s failure to provide the necessary callouts could have resulted from a feeling of intimidation in response to his relation to the captain’s authority in the hierarchy, indicating a clash of cognitive and social factors that led to miscommunication. The overall result was that the aeroplane overran the runway, crossed a drainage ditch and came to a standstill some distance past the end of the runway. Substantial damage to the aircraft was reported and one passenger was seriously injured (Cushing, 1997: 3).

Portland (Oregon) International Airport, USA (1978): The investigators identified the probable cause of the accident as “the failure of the captain to monitor properly the aircraft’s fuel state and to properly respond to the low fuel state and the crew member’s advisories regarding fuel state….” (Cushing, 1997: 3). The failure on the captain’s side was a result of “preoccupation with a landing-gear malfunction” (Cushing, 1997: 3) and preparations for a possible emergency landing. Another contribution to this accident was failure on the part of two other flight crew members “to fully comprehend” the critical fuel state and “to successfully communicate” their concern to the captain (Cushing, 1997: 3). This example is an interesting blending of aspects with regard to the realisation of the crew members and the preoccupation of the captain, but in this case (in contrast to the Monroe incident) the crew members

did provide appropriate advisories but failed to prompt the necessary action – they said something, but not something that conveyed the necessary degree of urgency. The captain's preoccupation with the landing-gear undermined his social obligation to respond to the "linguistic productions of interlocutors" (Cushing, 1997: 4). The aircraft crashed into a "wooded populated area" with the result that eight passengers, the flight engineer and a flight attendant were killed, and 21 passengers and two crew members were seriously injured (Cushing, 1997: 4).

Cardosi and Stein (1999) discuss a number of human factors important to pilot-ATC communication; these are briefly discussed in sections 2.3.2.1 to 2.3.2.5 below.

2.3.2.1 Memory

The human memory is unreliable and it needs all the help available. Therefore ATCs should use "memory-joggers" and cues – e.g. flight progress strips with specific information on different aircraft[8]. Distractions can overload short-term or "working" memory; therefore Cardosi and Stein suggest that ATCs should unclutter their work places and categorise information – e.g. different colour flight progress strips holders for departures and arrivals. Cardosi and Stein suggest that messages should be kept short and simple. When an ATC gives an instruction, it should not contain more than three pieces of information in a single transmission, since "the complexity of the controller's transmission has a direct effect on the pilot's ability to remember it." (Cardosi and Stein, 1999: 8) They also argue that a pilot's memory for an instruction is hindered by extraneous information presented before and after the instruction.

2.3.2.2 Expectations

Sometimes a clearance the ATC issues is different from what the pilot was expecting based on prior experience and the ATC should therefore emphasise the difference. To identify and correct read-back errors is difficult because humans tend to hear what they expect to hear. Cardosi and Stein suggest that ATCs should diligently check read-backs against flight progress strip notations. There are cases where two

[8] An example of a flight progress strip is provided in Appendix A.

aircraft have similar call-signs[9], e.g. FGC and FCG, and ATCs should warn pilots of other aircrafts with similar call signs in the same air traffic control situation (Cardosi and Stein, 1999: 11).

2.3.2.3 Speech rate

Cardosi and Stein emphasise the importance of speaking slowly and clearly. In increasing speech rate, many of the cues that help identify the difference between certain speech sounds are lost and therefore either misunderstandings or requests for repetition occur, especially for pilots whose native language is not English. They mention that the rate of pilot read-back errors doubles when ATCs issue complex clearances at even a moderately faster than normal speaking rate. Good microphone technique is important to both pilots and ATCs so that the first syllables or parts of transmissions are not clipped, especially where call signs are concerned (Cardosi and Stein, 1999: 18-19).

2.3.2.4 Personal limitations

Common threats to performance in radio transmissions are high workload and stress leading to tunnel vision (a defective vision that does not adequately include all necessary elements) as a result of a preoccupation with a specific problem or with a certain aspect of performing duties while flying or doing air traffic control. Stress impairs performance (and memory) and pilots and ATCs should be able to recognise their own personal signs of stress and those of their colleagues (Cardosi and Stein, 1999:21).

2.3.2.5 Fatigue

Adequate sleep is essential for role players in the aviation industry in order to perform optimally and to ensure physical and psychological well-being and alertness. Factors that may jeopardise a good sleeping pattern are the intake of caffeine and alcohol, smoking, light, heat and noise, and a lack of exercise. Regular and effective

[9] The registration number of an aircraft usually consisting of six characters, e.g. ZS-MUS, but only the last three characters are mostly used in air traffic control communication.

breaks are necessary to maintain alertness for complex tasks and good memory during performance either in the tower or in the aeroplane (Cardosi and Stein, 1999:27).

At this point it should be clear that sufficient command of the English language is one of the essential elements in successful pilot-ATC communication, but that other human factors, such as those referred to above, also affect air control communication.

2.3.3 Aviation English

2.3.3.1 Introduction

To provide but one example of aviation in a global sense, if a Chinese pilot flies from Beijing to Paris, he may fly across more than 10 national boundaries and engage in radio transmissions with more than 24 ATCs, with different L1s, speaking different regional varieties of English, and at various levels of proficiency (Shawcross, 2008: 1). Although standard phraseology is at the heart of Aviation English, Shawcross explains that in many non-routine or emergency situations, e.g. system failures, passenger illness, bad weather conditions, fuel shortage, and bomb scares, standard phraseology might not be adequate for unambiguous communication. In such cases it is essential that pilots and ATCs supplement the standard phraseology with plain or colloquial language to manage the specific situation. Examples of plain or colloquial language may include: *the cabin crew has reported three passengers concussed, possibly with broken ribs*; *we have ordered an ambulance to be standing by at the gate*; *there seems to be a fuel spillage on Taxiway November.*

Examples of standard phraseology in radiotelephony communications between pilots and ATCs are provided in section 2.3.4; below some general characteristics of Aviation English used in air traffic communications are discussed.

Aviation English is essentially oral and communicative because it entails discourse between pilots and ATCs by means of radio transmissions. Most of the communication between pilots and ATCs is without visual contact and therefore also

without the benefit of eye contact or body language. Pilots rely on their ears to acquire situation awareness (weather, obstacles and other aircraft in the environment in which they are flying, as well as the environment which they are flying into), and ATCs on the ground rely on their hearing to know what is happening to and on each flight.

A very specific and varied lexical corpus is employed by the operational aviation community, which includes weather, mechanics, aerodynamics, security, health, geography, human behaviour, navigation, airport infrastructure, and others. Aviation English uses common words in a different way than in everyday usage, e.g. words like *hold*, *clear* and *advise* have very specific meanings in Aviation English (see section 2.3.4 below). A range of operationally-relevant language functions and dialogue management is present in Aviation English, e.g. orders, requests, and offers to act. Radiotelephony communication is a blend of formulaic standard phraseology and common or natural speech if and when a non-routine situation occurs.

Aviation English is used in a stressful environment and time is a critical factor. The standard phraseology in Aviation English allows pilots and ATCs to manage movements and situations in the "most concise, regulated and unequivocal manner" (Shawcross, 2008: 2).

Shawcross (2008: 3) argues that "perhaps even more noteworthy than all the points above, is the sensitivity and the safety-critical nature of speech acts in operational aviation." It seems that every eventuality is provided for in aviation operations, and yet the unexpected happens. Language is then in a very real sense the final safety net. A series of safety barriers is set up in aviation to prevent accidents and to contain the effects of failure or human error. Shawcross (2008: 3) states that "language communication accompanies most of these barriers to make them more effective: pilot to pilot, pilot to controller, pilot to cabin crew." One would like accuracy and reliability in language use where situations could be critical, as in aviation. Therefore, people will have a more developed awareness of the essential role of oral communication in an increasingly complex and technological environment (Shawcross, 2008: 6).

In order to enhance safety in aviation, ICAO defined standards for the language used by pilots and ATCs. To quote from the holistic descriptors in ICAO Document 9835 Appendix A2:

> Proficient speakers shall:
>
> - communicate effectively in voice-only (telephone/radiotelephone) and in face-to-face situations;
> - communicate on common, concrete and work-related topics with accuracy and clarity;
> - use appropriate strategies to exchange messages and to recognize and resolve misunderstandings (e.g. to check, confirm or clarify information) in a general or work-related context;
> - handle successfully and with relative ease the linguistic challenges presented by a complication or unexpected turn of events that occurs within the context of a routine work situation or communicative task with which they are otherwise familiar; and
> - use a dialect or accent which is intelligible to the aeronautical community.

Now that we have established the role of language and human factors in aviation and what Aviation English entails, we turn to ICAO's language proficiency requirements, ratings and testing procedures for pilots and ATCs.

2.3.3.2 ICAO: Language Proficiency Requirements, Ratings and Testing

The SACAR 61.01.7 "Language" SACAA (2007), in compliance with ICAO's (2004) Document 9835, Chapter 6, as well as the Language Proficiency Test Report for Radiotelephony Communication, Form CA61-01.7 (2012), serve as the source documents for this discussion. Some paragraphs are provided verbatim as stated in the source documents – these are italicised in this section – and other information is provided by means of paraphrase or in summary.

2.3.3.2.1 Language proficiency requirements

ICAO has specified English language proficiency requirements, and mandated that these requirements shall be effective from 5 March 2008. *There are six levels of proficiency, and in accordance with the requirements, Pilots and Air Traffic Services Personnel shall demonstrate a minimum proficiency of at least Operational Level '4' of both ICAO Standard Phraseology and plain language, to be issued with or to maintain their respective licenses.*

The requirements further indicate that pilots and ATCs who have not been rated at Level 6 proficiency shall be tested for English language proficiency at regular intervals to ensure that they remain proficient at the required level; but those who have been rated at Level 6 proficiency, shall not require retesting. The six language proficiency levels are provided below.

Proficiency level	**Proficiency testing interval**
Level 6: Expert	Retesting not required
Level 5: Extended	Retesting required every six years
Level 4: Operational (Minimum level)	Retesting required every three years
Level 3: Pre-operational	License not issued/maintained
Level 2: Elementary	License not issued/maintained
Level 1: Pre-elementary	License not issued/maintained

The Language Proficiency Requirement applies to speaking and listening proficiency only and does not address the ability to read or write the English language.

2.3.3.2.2 Areas of proficiency that are assessed

The areas that are tested include:

- **pronunciation** – *the ability to speak in a manner that is clear and easy to understand*;
- **structure** – *the ability to compose concise, meaningful and unambiguous sentences or messages*;
- **vocabulary** – *the ability to use correct words and phrases to match the setting*;
- **comprehension** – *the ability to understand and follow instructions without difficulty*;
- **interaction** – *the ability to ask and answer questions, and engage in two-way dialogue without difficulty*; and
- **fluency** – *the ability to respond, narrate events or describe situations naturally*.

The licences affected by ICAO language requirements are those for aeroplane and helicopter pilots, glider and free balloons pilots, air traffic service personnel, and aeronautical station operators.

Since 1 August 2012, SACAA made it compulsory for cabin crew members, i.e. flight attendants, to also present a LPR Certificate and to comply with the same requirements as indicated for pilots and ATCs.

2.3.3.2.3 Language proficiency rating

The language proficiency rating (LPR) scales appear on the Language Proficiency Test Report for Radiotelephony Communication Form CA61.01.07 (2012), and describe the different areas that are assessed and the rating levels that are used in this assessment.

The overall rating is the minimum of the ratings for all the skills, e.g. someone with an adequate command of English but unintelligible pronunciation might get a “6” for

all the skills except pronunciation and the overall rating would then be the rating the candidate received for pronunciation, which may be a “4” or even a “3”. The form with guidelines used when assessing the different areas is provided as Appendix B.

2.3.3.2.4 Language proficiency testing

The language proficiency test takes the form of an interview of 20 to 40 minutes between the candidate and two examiners. The examiners must be registered and accredited by the CAA; one must be a linguist and the other an aviation expert[10]. Naturally the examiners must demonstrate full proficiency in English and they are required to sign a Code of Conduct concerning language testing practices. Training organisations, institutions and flying schools that wish to offer a Language Proficiency Test Service must be accredited by the CAA and all relevant information must be included in a Manual of Procedure.

The candidate must first register by completing the CAA assessment form and the assessment form of the company, institution or flying school. A short briefing follows in which the candidate(s) must be set at ease and the assessment criteria as well as the administrative process must be explained. In the interview, which is recorded for archiving, the examiners must agree on ratings for each of the skills that are tested and the candidates are evaluated on their use of plain language and aviation-related language. After the interview, a certificate must be printed and the candidate receives the certificate and the CAA assessment to submit in order to obtain a license or maintain an existing license. The sound recording and all the documents must be stored electronically in a centralised archive and must be retained for a minimum of six years. In the event that a candidate is rated at Level 3 or below, the CAA shall immediately be advised by providing them with a copy of the assessment form. The archived records are open for inspection and audits by the CAA.

Burger (2009) compiled a list of questions that are grouped in a range from “basic” to “extended” to “expert” command of the language. The reason for the different

[10] The requirements for Language Proficiency Raters/Interviewers can be perused in ICAO document 9835, Chapter 4 (4.3.1) (ICAO, 2004) and Appendix 1.5.2 to SA-CATS-FCL 61 (SACAA, 2008) for best practices.

groupings of the questions is to increase the level of complexity in grammar as well as to raise the level of abstractness of questions. A candidate who can only handle basic questions, will probably receive a “4”, a candidate who can successfully answer questions at the extended level will probably receive a “5”, and candidates who can successfully grasp the abstract questions and grammatical complexity of the expert level questions will most probably receive a “6”.

A mixture of non-aviation-related questions and aviation-related questions is used during the interview with the two examiners alternating as interviewers. The aviation-related questions are simulated flying scenarios in which the candidate is expected to make radio transmissions to the tower of an airport and the non-aviation-related questions are on general matters. This variation allows the examiners to determine whether the candidate understands varied accents and diction, but it is also necessary because of the nature of the questions.

The linguist, for example, mostly asks questions about everyday life matters; questions that evoke informative responses such as *Tell me about any hobbies or pets you have had* and *Give us an outline of your flying career thus far*.

The aviation expert, on the other hand, tests whether the pilot or ATC has the ability to organise logistics associated with a flight and also simulates non-routine situations. The candidate must do the necessary radio communication in response to the transmissions the aviation expert initiates. For example, the aviation expert makes a radio transmission from the control tower at an airfield familiar to the candidate, just after departure: *Bravo Charlie Zulu, we have just picked up a wheel on the runway that we think may belong to your aircraft. State your intentions please*; and the radio conversation must be followed to its logical conclusion. Examples of advanced questions are: *Please elucidate the impact the emancipation of women has had on the aviation industry* and *Describe some of the intangible advantages you developed through your involvement in aviation* (Burger, 2009).

Candidates who do not meet the Level 4 requirement are required to undergo remedial language training in order to address areas of difficulty. Candidates assessed below Level 4 as well as candidates who receive ratings at Levels 4 and 5

and wish to have a second test opportunity are required to wait for a period of 90 days before they can apply for re-assessment.

The validity and reliability of the current assessment procedure for pilots and ATCs, as well as remedial training of pilots and ATCs (who receive LPRs of Level 4 and below), fall outside the scope of this study, but could serve as material for future research.

2.3.3.3 Practical consequences of ICAO requirements

A summary of the different impacts of ICAO's English proficiency requirements on the aviation industry in general, based on Shawcross's (2008: 3-5) discussion, include the following:

Firstly, if we look at the consequences for aviation safety, it is an obligation for all flight crew members flying internationally and ATCs working in service centres where there is international traffic, to comply with the English proficiency requirements of ICAO; a force to increase the standards of spoken English in aviation communication on a world-wide scale. The result therefore is that pilots and ATCs are increasingly better prepared to deal with potentially dangerous situations and in general it develops a greater awareness in the aviation industry of the essential role language plays in air traffic communications.

Since March 2008 (with a conditional three-year period of extension until March 2011), all pilots and ATCs in an international environment are required to have an endorsement on their licenses to prove that they passed an approved test at least at Operational Level 4. Without the endorsement they are not able to continue operating legally in an international environment. Success or failure on a proficiency test therefore determines, amongst other things, whether or not a pilot or ATC retains his/her job, receives a promotion, is allowed to fly internationally, and has greater responsibility as an ATC. The testing obligations have an impact on how airlines and air navigation service centres manage the availability and training of their staff. The recent decision to enforce LPRs for flight attendants highlighted that the cabin crew industry was unprepared for such a decision and the demand for LPR

interviews for such crew members increased tremendously in order to obtain licenses and not to jeopardise prospective employment opportunities.

Regarding the social impacts, a universal requirement to demonstrate proficiency in order to obtain the endorsement of a professional license has consequences for profoundly different political and cultural groups all over the world. In certain cultures, for example, the power distance between captain and first officer (co-pilot) can be extreme and it would be very difficult for the first officer to question the captain at all. This power distance between crew members can result in potentially dangerous situations if there is insufficient interaction between the two pilots. A language proficiency testing system can most certainly upset this balance of authority if the captain's mastery of the English language is inferior to that of the junior officer and the captain's license is threatened by the result of the test. On the positive side, airlines being the national flag carriers of their countries could not risk their reputation being tarnished by negative publicity of having staff declared non-compliant with language proficiency requirements and will therefore support the use of a valid and reliable testing system. On a psychological level, highly qualified and respected professionals in their thirties, forties and fifties (who might have been in the aviation industry for some time before LPR testing became mandatory) may fail the language proficiency test or fear failure in a test that could affect their self-esteem and add to the anxiety in a profession which already requires regular medical check-ups, and numerous other professional checks.

There is no doubt that the ICAO Language Proficiency Requirements come at a cost to the industry – both in direct and indirect expenses. These expenses include procuring and administering sophisticated and secure custom-made tests for many pilots and ATCs on a recurrent basis as well as provision for extensive remedial training if they fail the test. In a global economy – where we find an intensely competitive market – any negative publicity about staff members' language proficiency can have a detrimental effect on the image of the airlines in the eyes of the travelling public. We have now entered a time where language proficiency enters people's awareness as a parameter to be taken into account in air travel safety.

To conclude: “Language Proficiency Interviewing/Rating is considered to be extremely ‘high stakes’ testing as it impacts on aviation careers and the critical issue of aviation safety.” (SACAA, 2008)

As standard phraseology forms the core of Aviation English, it is discussed in some detail in section 2.3.4 below.

2.3.4 Standard phraseology in Aviation English

In order to provide a characterisation and examples of standard radiotelephony phraseology, the researcher used ICAO’s (2007) *Manual of Radiotelephony*, Doc 9432 AN/925 (henceforth, “the MRT”).

2.3.4.1 Introduction

The aim of ICAO’s standard phraseology is to ensure efficient, clear, concise, and unambiguous communications. Although it is not possible to provide phraseologies for every conceivable situation, the examples provided in this section are representative of radiotelephony phraseology in common use. The standard phraseologies may be supplemented with plain language, but when it is necessary to use plain language, it should comply with the same principles that govern the development of phraseologies, i.e. plain language communications should also be clear, concise, and unambiguous.

Awareness of the special difficulties that non-native English speakers face contributes to safer communications. It is emphasised that transmissions should be done slowly and clearly and that direct statements without idiomatic expressions are easier to understand than indirect statements, colloquialisms and slang.

Certain countries or states may specify in their Aeronautical Information Publication specific requirements on first contact when an aircraft enters their airspace or prior to leaving the airspace. Pilots have to familiarise themselves with such procedures before they undertake international flights.

Radiotelephony is the means by which pilots and ATCs communicate with each other. The communications containing information and instructions are of vital importance in the safe and expeditious operation of aircraft and the importance of correct and precise standardised phraseology cannot be underestimated or overemphasised. An overview of different elements in radiotelephony communications is provided below.

2.3.4.2 Transmitting technique

To ensure that transmitted speech is clearly and satisfactorily received, flight crew members and ATCs should be familiar with good microphone operating techniques and speak clearly and slowly. Pilots and ATCs should further maintain an even speech rate, maintain an appropriate speaking volume and avoid using hesitation sounds such as *uh* and *er*. The transmit switch must be fully depressed before speaking and it must be released when the message is completed. Long messages should be interrupted from time to time to permit the operator to confirm that the frequency is clear, and to permit requests for repetition of parts of the message.

2.3.4.3 Transmission of letters

The words in the list below are used for phonetic spelling of the letters of the alphabet, taken from the MRT. Underlined syllables are emphasised.

Letter	Word	Pronunciation
A	Alpha	al fah
B	Bravo	brah voh
C	Charlie	char lee
D	Delta	dell tah
E	Echo	eck oh
F	Foxtrot	foks trot
H	Hotel	ho tell

I	India	in dee ah
J	Juliett	jew lee ett
K	Kilo	key loh
L	Lima	lee mah
M	Mike	mike
N	November	no vem ber
O	Oscar	oss cah
P	Papa	pah pah
Q	Quebec	keh beck
R	Romeo	row me oh
S	Sierra	see air rah
T	Tango	tang go
U	Uniform	you nee form
V	Victor	vik tah
W	Whiskey	wiss key
X	X-ray	ecks ray
Y	Yankee	yang key
Z	Zulu	zoo loo

2.3.4.4 Transmission of digits

Digits, and how they are transmitted using specific pronunciation, as provided in the MRT, are set out below. In the column with the correct pronunciation, the syllables in upper case are stressed. The digits *five* and *nine* sound too similar; therefore the pronunciation has been changed to *FIFE* and *NIN-er* to make them more distinguishable in radio communication.

Number	Word	Pronunciation
0	Zero	ze-ro
1	One	wun
2	Two	too
3	Three	tree
4	Four	fow-er
5	Five	fife
6	Six	six
7	Seven	sev-en
8	Eight	ait
9	Nine	nin-er

To illustrate the use of the phonetic alphabet letters and the digits in aviation, the following example is given:

A pilot will call the tower and identify himself by the aircraft's call-sign UDB by saying:

UDB: City Tower, Uniform Delta Bravo.

Twr: Uniform Delta Bravo, go ahead.

UDB: Uniform Delta Bravo inbound at Suburbia, five thousand five hundred feet. Request joining and landing.

Twr: Uniform Delta Bravo, join left downwind runway 01, five thousand six hundred feet, QNH[11] 1025, report left downwind.

UDB: Report left downwind 01, QNH 1025, Uniform Delta Bravo.

[11] QNH is one of many Q codes which was used in the days of telegraphy as a rudimentary lingua franca. It is defined as "barometric pressure adjusted to sea level" - a pressure setting used by pilots, air traffic control and low frequency weather beacons. As a statement (e.g. QNH 1025) it means "if you set your altimeter subscale to this setting, your altimeter will indicate the correct elevation on touchdown". As a question (e.g. "QNH?") it means "What setting must I set on my subscale to indicate the correct elevation on touchdown?" There are Q codes for most standard phrases in aviation and shipping (http://en.wikipedia.org.wiki/QNH and Burger, 2012).

2.3.4.5 Standard words and phrases

The MRT also provides some frequently used words and phrases, together with the meaning in the specific context of air traffic control. A number of examples are provided below.

Word/Phrase	Meaning
Acknowledge	Let me know you have received and understood the message
Affirm	Yes
Approved	Permission for the proposed action is granted
Cleared	Authorised to proceed under the conditions specified
Correction	An error has been made in the transmission; the correct version is transmitted
Disregard	Ignore
Say again	Request for repetition of instruction/information
Maintain	Continue in accordance with the specified conditions
Negative	No
Report	Make contact in accordance with instructions
Speak slower	Reduce the speech rate
Stand by	Wait and I will call (The caller would re-establish contact if the delay is lengthy. 'Standby' is not an approval or a denial)
Go ahead	Sometimes used by the ATC after contact has been established by the pilot transmitting the call sign of the aircraft

Roger	I have received all of your last transmission
Wilco	Abbreviation for “will comply”

2.3.4.6 The use of standard phraseology in practice

The example of standard phraseologies below is based on a question in the *Superb Flight Training English Proficiency Examination Manual* (Burger, 2009: 9).

In a simulated abnormal situation the examiner pretends to be the ATC. An aircraft with the call sign, ZS-MUS, has just departed from Gate Ridge (a fictitious airport name) when the ATC makes a radio transmission from the control tower:

ATC: ……	*Mike Uniform Sierra, we have just picked up a wheel on the runway that we think may belong to your aircraft. State your intentions please.*
Pilot: ……	*Mike Uniform Sierra, request a low flyby past the tower for inspection of undercarriage.*
ATC: ……	*Mike Uniform Sierra, low flyby approved. Join left downwind runway zero one, five thousand feet.*
Pilot: ……	*Left downwind runway zero one, five thousand feet, Mike Uniform Sierra.*

The pilot continues and does a flyby past the tower so that the ATC can inspect the aircraft’s undercarriage.

ATC: ……	*Mike Uniform Sierra, undercarriage appears intact, state your intentions please.*
Pilot: ……	*Will continue with circuits, Mike Uniform Sierra.*
ATC: ……	*Mike Uniform Sierra, join left downwind runway zero one at five thousand feet. QNH one zero three one.*

Pilot: ……	*Left downwind, zero one at five thousand feet, one zero three one, Mike Uniform Sierra.*
ATC: ……	*Mike Uniform Sierra.*
Pilot: ……	*Mike Uniform Sierra, left downwind zero one, full stop.*
ATC: ……	*Mike Uniform Sierra, report final approach zero one, keep a lookout for traffic from the west.*
Pilot: ……	*Report final approach zero one, copied traffic, Mike Uniform Sierra.*
ATC: ……	*Mike Uniform Sierra.*

(Burger, 2009)

During an informal interview with Burger (2012), who regularly does flights beyond the borders of South Africa, he commented on a situation in East Africa where a deviation from standard phraseology is frequently used by ATCs. In this region, ATCs often conclude a transmission with the word *correct* after the pilot has done the read back of the instructions. This deviation from standard phraseology could potentially develop into hazardous or dangerous situations, because without the call-sign of the aircraft, more than one pilot might simultaneously consider the word *correct* as the conclusion to their communication on air. The standard phraseology from an ATC to conclude a transmission for a specific aircraft is unambiguously with the aircraft's call sign, as in the example above.

Aviation English is used in a specific professional setting (aviation/airspace) and serves as a means for executing tasks and activities in airspace (to safely take off, fly, and land aircraft). Therefore, in the researcher's opinion, Aviation English can be classified as institutional talk, which is briefly discussed in the next section of this chapter.

2.4 Institutional talk

When people deal with organisations, institutions and professionals, they engage in institutional talk. The term “institutional talk” describes the means by which practical tasks and different activities are performed to meet organisational or institutional goals (Gardner in Davies and Elder, 2004: 277).

The main focus on talk in institutional settings is the methods and practices to which participants are oriented and how they play out their institutional identities, especially in turn-taking practices and types of actions. Basic methodological and theoretical principles are combined to examine at micro-level participants’ conduct through the talk they produce.

Three important aspects of institutional talk are:

(i) a stable understanding by the participants of the objectives of the task at hand;
(ii) constraints that are placed on the participants, e.g. where roles are clearly defined in professional settings, and the degree of constraint may vary according to the institution and the professional setting in which the interaction takes place; and
(iii) different ways in which participants make inferences or think while they are taking part in the interaction in terms of, for example, responses, opening utterances, closing utterances, and fillers.

These three aspects form an institutional footprint which identifies the institutional talk (Gardner in Davies and Elder, 2004: 277-278).

In the researcher’s opinion, pilot-ATC communication has a unique institutional footprint in that Aviation English with standard phraseology has to be used with specific roles and identities assigned to pilot and ATC, respectively. That pilot-ATC communication has an institutional footprint is clear when one considers the three aspects of institutional talk referred to above. Firstly, there has to be a stable

understanding by pilots and ATCs of the objectives of the task at hand, i.e. to take off, fly and land aircraft safely, on the one hand, and to manage air traffic effectively in order to avoid hazardous situations (e.g. comply with instructions issued by ATCs). Secondly, pilots and ATCs need to understand and accept the constraints of standard phraseology and Aviation English in order to effectively and unambiguously communicate with each other; in addition, they need operational proficiency in plain English to negotiate meaning in cases where Aviation English fails to repair miscommunication or where Aviation English proves to be inadequate to convey the seriousness of the situation. Finally, there are different ways in which pilots and ATCs make inferences or think while they are taking part in the interaction in terms of the appropriate responses (timely read backs and specific aviation terminology to confirm, correct and request), opening utterances (in terms of aircraft call-signs and the like), and closing utterances (to conclude a sequence of pilot-ATC communication).

Naturally occurring events of talk in interaction are needed as data in order to analyse institutional talk. In this study, the relevant data consist of audio recordings of naturally occurring events of pilot-ATC talk in interaction. The analysis of such data is based on the evidence of the produced talk in conversations between members of a community (in this case, the aviation community), which is usually followed by a discussion of the findings. The analysis is done by playing the recording repeatedly so that the analyst becomes increasingly familiar with the data, through repeated listening and through the transcription process. The transcription process serves as a tool for the analyst to become as closely familiar with the data as possible; in fact, the act of transcription becomes the act of analysis. It is important to start with a detailed description at micro-level without a definitive description at first, transcribing only what is “hearable” and “seeable” within the context of the talk in interaction (Gardner in Davies and Elder, 2004: 267).

Context is here understood as the immediate configuration of the activities, and the larger environment of the activity. In institutional talk, the context is constantly renewed through maintenance, adjustment, or alteration of a broader (more general) sense of context. In other words, what is said, will be interpreted in view of what has been said before (context-shaped), and what is said will also provide the context for

the interpretation of following utterances (context-renewing) (Gardner in Davies and Elder, 2004: 269).

The next section contains a discussion of two studies that involved the analysis of air traffic control communications.

2.5 Pilot-ATC communication

Two studies conducted outside South Africa provide a good frame of reference for the analysis of air traffic control communications. They contain some useful tools for analysing the specific institutional talk under investigation in this thesis, namely pilot-ATC communication and provide a highly relevant model for analysis, referred to as the SHELL model. These studies are discussed below.

2.5.1 European Organisation for the Safety of Air Navigation (Belgium)

In a study conducted by Gerard van Es of the National Aerospace Laboratory under a contract awarded by Eurocontrol in April 2004, air-ground communication safety was investigated. This project was proposed within the Eurocontrol Safety Improvement SUB-Group (SISG) as a subject for a Safety Improvement Initiative. The study provides a synthesis of issues related to safety in aviation with specific reference to air-ground communication in support of the SISG activities (Van Es, 2004: 1).

A total of 444 less serious accidents, which occurred between January 2002 and August 2003, which were considered to be representative of the situation in Europe, were analysed. The project was limited to commercially operated large aircraft (with a take-off mass of 5 700 kg or higher) (Van Es, 2004: 7). The analysis reported on data in the NLR Safety Database with regard to “occurrences of less serious incidents as obtained from airline reporting systems and confidential reporting systems” due to the fact that serious incidences and accidents would comprise too small a sample to draw on to reach meaningful conclusions. Additional data of less serious incidents and accidents, reported to regulators by Air Navigation Service

Providers and airlines, were also used, and care was taken to remove duplications from the final sample. There were no restrictions regarding where the incidents happened, but, as mentioned before, only occurrences considered to be relevant to Europe were selected for the study (Van Es, 2004: 7).

The taxonomy used included classifying the consequences of air-ground communication problems:

(i) **altitude deviations** – a departure from, or failure to attain, an altitude assigned by the ATC;
(ii) **runway transgressions** – the erroneous or improper occupation of a runway or its immediate vicinity by an aircraft that poses a potential collision hazard to other aircraft using the runway (even in the event of no other aircraft actually present);
(iii) **wrong clearances** – accepted by pilots (call-sign omission or discrepancies) or ATCs (when pilots do not conclude the discourse with a call-sign);
(iv) **prolonged loss of communication** – no response from aircraft when called by the ATC or other aircraft;
(v) **loss of separation** – less than the prescribed separation between aircraft;
(vi) **heading or track deviations** – failure to fly assigned heading/track;
(vii) **instruction issued to wrong aircraft**;
(viii) **unknown consequences**; and
(ix) **no consequences**. (Van Es, 2004: 8-9)

Generic communication problems included in the taxonomy were:

(i) **Read-back/hear-back errors** – the pilot reads back the clearance incorrectly and the controller fails to correct the error or the pilot of the wrong aircraft who reads back the instruction.
(ii) **No pilot read-back** – the pilot does not indicate to the ATC that he/she understands the clearance.
(iii) **Hear-back errors** – the ATC fails to notice his/her own error in the pilot's correct read-back or fails to correct critical erroneous information in a pilot's statement of intent.

(iv) **Communication equipment problems** – improper functioning of communication equipment in the aircraft or on the ground.

(v) **Loss of communication**

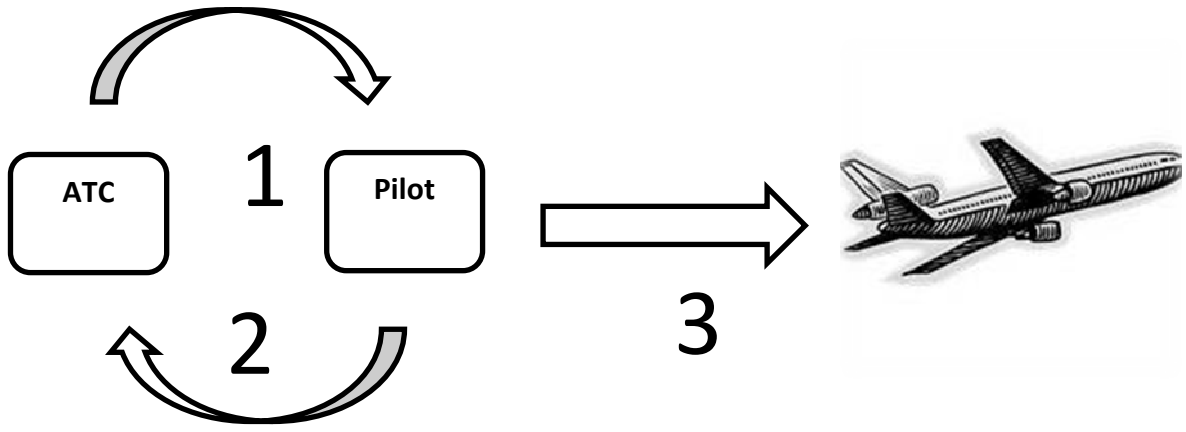
(vi) **Other communication problems**

The communication factors are referred to as items, which were judged to be instrumental in the chain of events which caused the occurrence (Van Es, 2004: 8-9)

Other factors taken into account included ambiguous phraseology; blocked transmissions; inaccuracies and incompleteness of content of messages; a speaker's accent or non-native pronunciation; distractions; fatigue; high speech rate; workload; frequency change; frequency congestion; garbled messages; issue of strings of instructions to different aircraft; language problems; long messages; partial read-backs; expectations; radio malfunction; radio interference; similar call signs; stuck microphone; and untimely transmissions (Van Es, 2004: 9).

This report (Van Es, 2004: 31) provides a model representation of a flawless communication event between a pilot and an ATC, which is graphically represented in Diagram 1 below.

Diagram 1: A model of flawless pilot-ATC communication



1. ATC issues an unambiguous instruction to the pilot.
2. The pilot reads back the message correctly.
3. The pilot executes the instructions flawlessly. (Van Es, 2004: 32)

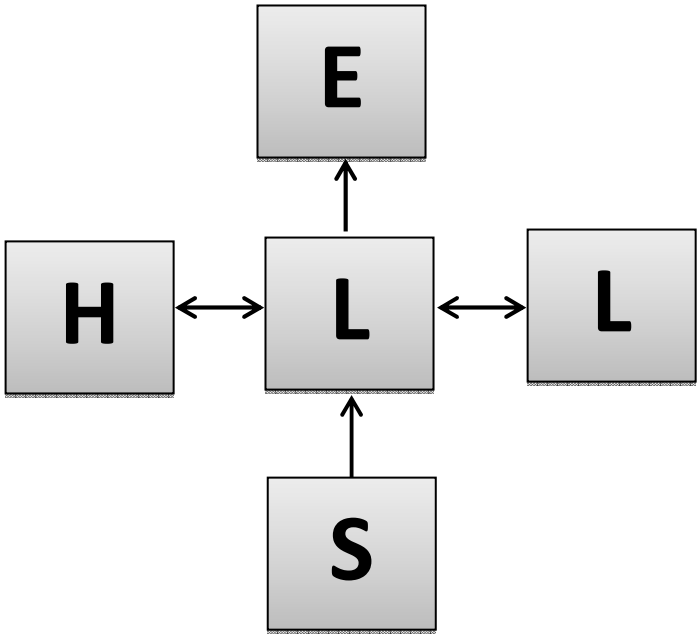
The SHELL model, developed by Edwards in 1972 and modified by Hawkins in 1975, is a generic causal model. With reference to its use in air traffic communication, the model was included in a Human Factors Training Manual, published by ICAO in Circular 216-AN31 in 1998 (ICAO, 1998). The model serves as a conceptual framework to assist in understanding human factors and is a useful tool to comprehend why and how communication errors occur in terms of human factor elements, broken down into four conceptual categories (Van Es, 2004: 31). The letters in the acronym SHELL represent:

Software; **H**ardware; **E**nvironment; and **L**iveware (twice)

The human factors (in the centre of the model as illustrated in Diagram 2 below), categorised under "liveware", include factors related to the psychological state and the physical well-being of the pilot or ATC.

The SHELL model is represented in terms of four interfaces, as illustrated in Diagram 2:

Diagram 2: The SHELL building block model



L – **H** is the Liveware-Hardware or "Human-Machine" interface, concerned with the displays, switches and controls. This interface addresses the mismatch in the

human-machine relationship and the source of confusion and error caused by poorly designed equipment.

L – **S** is the Liveware-Software or “Human-System” interface, concerned with the non-physical aspects of the system, i.e. procedure, operating manuals and checklists.

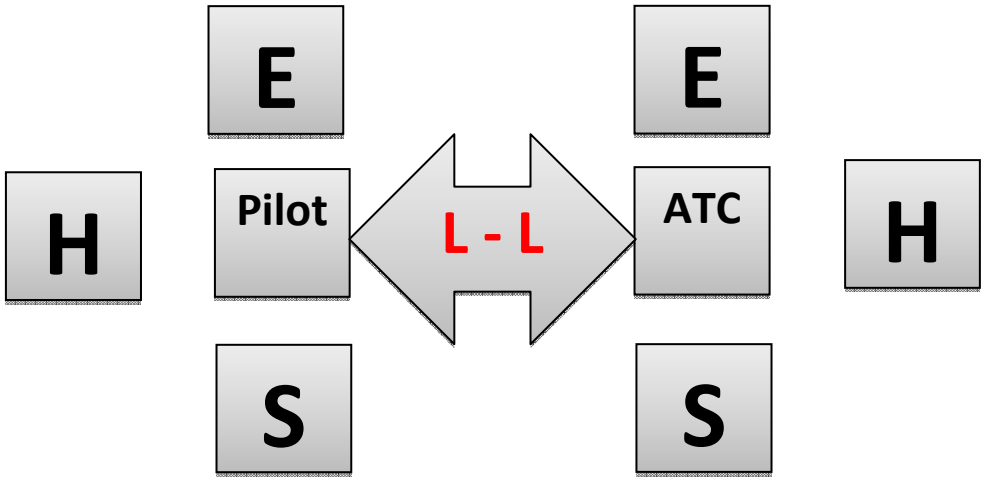
L – **E** is the Liveware-Environment or “Human-Environment” interface, concerned with environmental factors such as noise, heat and lighting.

L – **L** is the Liveware-Liveware or “Human-Human” interface, concerned with the interface between people. In this interface, shortcomings reduce operational efficiency and subsequently misunderstandings and errors occur (Van Es, 2004: 32).

In the SHELL model, the match or mismatch of an interface is as important as the characteristics of the blocks themselves and it is important to remember that a mismatch of an interface can be a source of human error. In this study, although all four interfaces inevitably play a role in the model of communication between a pilot and an ATC, the L-L interface is the main focus, and occurrences of mismatches at this interface level will be investigated to identify misunderstandings or communication problems and the cause(s) thereof.

As in the Eurocontrol study, the SHELL model provides a simple framework within which some of the common features of pilot-ATC communication problems can be discussed. The SHELL model is somewhat extended to accommodate pilot-ATC communication problems because there is an interface between the pilot and the ATC, between the pilot and controls, and between the ATC and controls. Therefore, the model can be presented as in Diagram 3:

Diagram 3: The extended SHELL model of pilot-ATC communication



(Van Es, 2004: 34)

The frequency distribution of the generic communication problems in pilot-ATC communication for the whole data sample was as follows: read-back/hear-back errors – 31%; loss of communication - 20%; communication equipment problem – 18%; hear-back errors – 5%; no read-back – 3%; and other problems – 24% (Van Es, 2004: 12).

The consequences of communication problems for the whole data sample varied from no consequences to prolonged loss of communication, altitude deviations, wrong aircraft accepted clearances, losses of separation, runway transgressions, heading or track deviations, and instructions issued to wrong aircraft (Van Es, 2004: 13).

This study showed that only a small fraction of all communication errors result in reportable occurrences. The researcher who conducted this Eurocontrol study, correlated the findings by means of a “quick and dirty” analysis of air-ground communication-related accidents in the NLR Air Safety Database during the period 1980-2002. The accident samples presented similar problems as in the Eurocontrol study, such as the use of non-standard phraseology by pilots and ATCs, incorrect read-backs, hear-back errors, call sign confusion, radio malfunction and language problems (Van Es, 2004: 39).

In conclusion of the discussion on this study, Van Es states that in spite of the low frequency of occurrence, communication problems in air traffic control can result in high-risk hazardous events because of the seriousness of the consequences. He states the top six factors as: similar call signs, sleeping VHF (very high frequency) receivers[12], frequency change, incorrect read-backs, radio interference, and use of non-standard phraseology by ATCs. Van Es also points out that many of the problems that were identified in this study have been reported in older studies, but since the scale of aircraft operations has increased over time, the problems have become more evident than they were 20 years ago (Van Es, 2004: 39).

The researcher is of the opinion that the abovementioned model is applicable to this research study where both the occurrence of non-standard phraseology, i.e. deviations from Aviation English (language-related factors in communication errors), as well as non-language-related factors in communication errors are investigated. Thus, although the main focus is on the Liveware-Liveware component of the SHELL model, the Liveware-Hardware and Liveware-Software components definitely play a role in the analysis of pilot-ATC communication as a whole.

A second study focused on causes of communication errors in pilot-ATC communication with specific reference to pilot read-backs. The latter is highly relevant to the research reported in this thesis due to the fact that elements like requests for repeats, similar call-sign confusion, call-sign discrepancies, read-back errors (pilots) and hear-back errors (ATCs) are all items where deviations from Aviation English and standard phraseology can occur.

2.5.2 John A. Volpe National Transportation Systems Center (USA)

The Federal Aviation Administration's Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) funded a research project in which communication errors in voice recordings of air traffic control in the terminal radar control (TRACON) environment were analysed. The report commences by stating

[12] A loss of communication type in which the VHF frequency is silent for a period of time (Van Es, Eurocontrol 2004: 9).

that in the sheer volume of communications between pilots and ATCs, human error is inevitable. There is a constant opportunity for miscommunication and the consequences can range from just annoyance to serious accidents. The report explains that information obtained by analysing recordings of pilot-ATC communication is useful in many ways, i.e. it provides insights into the frequency of the occurrences of specific practices that are known to have an influence on the efficiency of communication, but it also provides an opportunity to address specific questions that need to be answered to evaluate and develop systems and procedures (Cardosi, Brett and Han, 1997: vii).

Pilot-ATC communications are not rigidly uniform (Cardosi, Brett and Han, 1997: 1). The format and wording of messages that are relayed between pilots and ATCs vary as a complex function in the airspace environment, and workload and individual style also play a role. Previous work in pilot-ATC voice communication (recordings) focused on ground, local control (tower) and en route communications, and a striking similarity was found in the communication practices in each environment, namely the error rate in read-backs by pilots was less than 1%. In 1993, in the TRACON environment, studies showed a read-back error rate of less than 1% and only 50% of these errors had been corrected by ATCs (Cardosi, Brett and Han, 1997: 1).

This research project's method involved the examination of 48 hours of voice recordings from eight different TRACON facilities in different geographical locations, different workload levels (24 hours high workload and 24 hours low workload), and different traffic mixes. These recordings included 13 089 transmissions between pilots and ATCs with 9 409 clearances and 3 680 requests for information. The recordings from each TRACON were from non-consecutive hours in one hour increments and were analysed by three aviation experts, i.e. one former ATC and two pilots (Cardosi, Brett and Han, 1997: 1).

The analysis examined communication errors and pilots' requests for repeats of parts or all of the transmissions made by the ATC. Pilot read-back errors, as a function of the complexity of the ATC's message, were studied where the message complexity was measured in terms of the separate elements in a single transmission. Each word, or a set of words, uttered by the ATC that contained new information for

the pilot (critical to comprehension), was considered as a separate element, i.e. the pieces of information that would increase memory load were counted as separate elements, excluding aircraft call signs. However, the number of pieces of information was not the only factor in measuring read-back accuracy; errors with regard to the type of information that was transmitted, were also analysed. The majority of messages (59%) contained one or two pieces of information, 15% contained three elements, and 25% contained four or more elements (Cardosi, Brett and Han, 1997: 3-4).

As the study focused on read-backs by pilots, it was found that 60% of the responses to ATC messages contained full read-backs, 26% contained partial read-backs, 5% contained acknowledgment only, 7% were other replies and 2% provided no acknowledgement. Each time a read-back is only partial or is totally omitted, an opportunity for a communication error occurs because it does not provide the opportunity for the ATC to make sure that the pilot has received the message. However, less than 1% of the read-backs in this study contained an error, where the error rate refers to instances where the pilot read back a speed restriction, an altitude, or a heading that differed from what the ATC originally said (Cardosi, Brett and Han, 1997: 6).

In this study, miscommunication comprises read-back errors, hear-back errors and requests to repeat all or part of the ATC's transmission. The authors argue that many factors can contribute to miscommunication, but one important factor that often led to read-back and hear-back errors, was expectation. Humans are predisposed to hear what they expect to hear and expectations were apparent in some of the errors that were noted. Eighty-one read-back errors were found in the recordings and four of the read-backs each contained two errors (Cardosi, Brett and Han, 1997: 9). Some of the more specific findings of the study are summarised in sections 2.5.2.1 to 2.5.2.5 below.

2.5.2.1 Message complexity and read-back errors

The complexity of the messages is divided into levels, where the level with the least pieces of information the pilot has to remember in a single ATC transmission is the

lowest level of complexity. The level with the most pieces of information the pilot has to remember in a single ATC transmission is the highest level of complexity. All elements containing information a pilot has to remember (e.g. taxiways, runways, and whom to follow) were counted to compute the complexity level. Most of the instructions contained three or fewer pieces of information, but more than 35% of the instructions contained four or more elements of information. For example, at Level 5 (approximately five pieces of information the pilot has to remember), 17 of the 475 read-backs contained errors, constituting a read-back error rate of 3.6%. It was found that the read-back error rate increased steadily with the complexity level; the more information included in a single transmission, the higher the probability of a read-back error. One factor that influences read-back errors is the degree to which the pilot is familiar with the location and the procedures of the airport; the degree of familiarity affects the memory load imposed by the transmission. The analysis counted each piece of information as equal and independent, but many of the pieces could have been grouped together by the pilot, in which case the information would impose a lower memory load (Cardosi, Brett and Han, 1997: 8-9).

2.5.2.2 Read-back errors (type of information)

ATC instructions are numerically intensive. Transposing numbers in a message can lead to errors and sometimes pilots confuse groups of numbers, e.g. they confuse the speed with the heading, reading a message like *Fly heading three one zero and reduce speed to two one zero*, back as *three ten on the speed, two ten on the heading* (Cardosi, Brett and Han, 1997: 10). In this instance, the ATC missed the read-back error. The authors emphasise that although read-backs may be correct, they do not ensure that a pilot will perform as expected, e.g. in one case the pilot repeated the frequency correctly, but then dialled in the wrong frequency and had to call back to get the frequency again (Cardosi, Brett and Han, 1997: 11).

2.5.2.3 Hear-back errors

This study found 32 instances in which the ATCs did not notice errors in read-backs by pilots, which means that 40% of the read-back errors resulted in hear-back errors. In one instance, a pilot requested a repeat of the heading, but the controller repeated

the frequency; this miscommunication escalated because the pilot interpreted part of the frequency for heading, but fortunately the error was corrected by the ATC in a single transmission (Cardosi, Brett and Han, 1997: 11).

2.5.2.4 Requests for repeats

Requests for repeats add to the workload on both pilots and ATCs. There were 127 instances of requests for repeats of all or parts of the transmissions the ATC made. Most of the requests (60%) were for partial repeats and the remaining 40% of requests were for repeats of the whole transmission (Cardosi, Brett and Han, 1997: 12).

2.5.2.5 Call-sign discrepancies

There were instances where pilots and ATCs responded to one another using different call signs; specifically, there were 79 instances where a pilot responded to a message with a call sign different from the one used by the ATC. A few aircraft had more than one instance of call sign discrepancies, but none of these errors resulted in hazardous situations (Cardosi, Brett and Han, 1997: 13).

Other factors as possible coincident events with miscommunications were found to be: instances in which wrong aircraft responded to transmissions of clearance, which were potentially serious errors, but were repaired effectively by the ATC; similar sounding call signs on the same frequency; blocked transmissions (stuck microphones); and foreign accents (Cardosi, Brett and Han, 1997: 15).

In conclusion, the report noted that although it is commendable that so few errors were found, with a read-back error rate of less than 1%, the analysis suggests simple changes in current practices that could reduce the risk of communication errors in pilot-ATC discourse.

Pilots should be conscientious about their microphone technique, they should ask for clarification, be diligent in using full call signs, and read back the full clearance. ATCs should keep their transmissions brief, listen for call signs, as well as the content of

pilots' read-backs to question any discrepancies, they should actively listen for read-back errors, and warn pilots continually when there are similar call signs on the same frequency. Both pilots and ATCs should use standard phraseology of Aviation English as it was developed with the aim of unambiguous air traffic control communication (Cardosi, Brett and Han, 1997: 17-18).

2.6 Conclusion

The two theoretical pillars of this research project are, firstly, English as lingua franca, because of ICAO's decision to enforce the use of English as the shared language in aviation globally and, secondly, Aviation English with standard phraseology, as explicated in this chapter. This chapter also presented two analytical studies on pilot-ATC communication, from which two analytical tools were extracted for the purposes of the study reported in this thesis, namely the SHELL model which was successfully applied to the analysis of voice recordings, and the taxonomy of elements in pilot-ATC communication where deviations from Aviation English and standard phraseology may occur. In the next chapter (Chapter 3), the research design and methodology are outlined. The research consisted of the collection and analysis of two sets of data, viz.: (i) responses to a questionnaire, completed by pilots and ATCs in South Africa; and (ii) real-life voice recordings of air traffic control communications at two airports in South Africa.

Chapter 3: Research Design and Methodology

3.1 Introduction

As outlined in Chapter 1, this study investigates English as lingua franca in aviation in South Africa. This chapter discusses the research methodology, participants and data collection instruments of the study reported in this thesis. Both quantitative and qualitative data were collected for this study. The quantitative data (Data Set I) were collected by means of a questionnaire, while the qualitative data (Data Set II) involve real-life voice recordings of discourse between pilots and ATCs. Section 3.2 describes the questionnaire and provides details of the respondents, while section 3.3 describes the process of obtaining the voice recordings and describes how these data were analysed.

3.2 Data set I: Questionnaire

The researcher compiled a questionnaire (see Appendix C), comprising three sections, for pilots and ATCs in South Africa. Section 1 contains aviation-related questions and was different for pilots and ATCs because of the difference in their qualifications and the nature of their work experience. Sections 2 and 3 were the same for pilots and ATCs. Section 2 elicited bio-demographic information from the respondents, while Section 3 was developed to elicit data for addressing the research questions under objectives 1 and 2 (see section 1.2) regarding pilots' and ATCs' perceptions of the role of language in air traffic communication, as well as their perspectives on ELF in aviation, and English language proficiency standards and testing for pilots and ATCs.

The questionnaire was made available online and pilots and ATCs from a number of different associations and flight schools were invited to complete it[13].

[13] The researcher is extremely grateful for Chris R. Burger's assistance in disseminating the information with regard to the survey to the Guild of Air Traffic Controllers in South Africa, SA Express Airline, CSIR researchers, 111 Squafron and 104 Squadron of the SAAF, Aircraft Owners and Pilots Association of South Africa (AOPA), Aviation Watch SA (AWSA), World Airnews, SA Flyer, African

3.2.1 Questionnaire design

The online questionnaire was structured as follows:

After the respondent had consented to participate in the study, they were asked to indicate their location. Location was necessary because the invitation to complete the questionnaire had been distributed so widely that there was a possibility that pilots and ATCs beyond South African borders would respond, and such respondents' data would have to be discarded as the study only investigates the situation in South Africa. (Responses from outside South Africa might prove useful in later studies.)

Next, the respondent had to indicate whether he/she is a pilot or an ATC and depending on their response, the questionnaire navigated to the appropriate pages for pilots and ATCs respectively. The pilots' Section 1 contained nine questions, and the ATCs' contained four questions, all regarding the respondents' aviation-related qualifications, experience and career.

The questions in the pilots' Section 1 were the following:

1. Which category best describes your flying career?
2. Which category includes your total of flying hours?
3. Indicate your highest completed flying qualification.
4. Indicate the aircraft on which you received or still receive flight training.
5. Do you have an instrument rating?
6. Do you have an instructor rating?
7. Which of the following types and classes of aircraft do you fly at least once a month?
8. How many flights do you typically fly each month?
9. How often do you do flights beyond South African borders?

Pilot, SFT, Global Aviator, Airline Pilots' Association (ALPA), and Air Traffic and Navigation Services (ATNS) in South Africa.

The questions in the ATCs' Section 1 were the following:

1. What is your highest qualification in Air Traffic Control?
2. How long have you been working as an ATC?
3. What is your current function in ATC?
4. Do you work in an air traffic services unit that handles international air traffic?

Section 2 contained five questions regarding, respectively, the respondents' age, non-aviation qualifications, language of education, mother tongue, and province in which they were living at the time of completing the questionnaire.

Finally, Section 3 contained eight questions:

1. How many times have you experienced radio communication problems while flying/doing air traffic control?
2. How many times have you been in threatening situations while flying/doing traffic control, where communication problems contributed to the situation?
3. How confident are you that problems in communication among pilots and ATCs in South Africa are resolved quickly and easily in order to avoid accidents?
4. In your opinion, which category is most often the cause for communication problems among pilots and ATCs? (Choose all applicable)
5. Do you think it is possible that language-related communication problems among pilots and ATCs can cause fatal accidents and serious incidents?
6. Do you support English Language Proficiency standards and testing among pilots and ATCs in South Africa?
7. Do you agree with the use of English as the common language in a multilingual aviation community nationally and internationally?
8. In general, how would you rate the English language proficiency standard of pilots and ATCs in South Africa?

Each of the questions was followed by a number of response options from which the respondent could choose. The data collected through Sections 1 and 2 are used to describe the respondents in section 3.2.2 below, while the data collected through Section 3 are discussed in detail in the next chapter.

3.2.2 The respondents

A total of 268 respondents completed the questionnaire, of which 201 were pilots and 67 ATCs, all from Southern Africa. Four pilots and one ATC indicated their location to be beyond the borders of Southern Africa and these five respondents' data were discarded for the purpose of this study. In the end, responses from 197 pilots and 66 ATCs were used in this study, constituting a total of 263 respondents.

3.2.2.1 Bio-demographic information

With regard to the ages of the participants, the majority (51%) of pilots were 50 years or older and the majority (77%) of the ATCs were 39 years or younger.

Table 1 below indicates the number of ATCs and the number of pilots from each province in South Africa.

Table 1: Province representation of ATCs and Pilots

Province	ATCs	Pilots
Eastern Cape	9	2
Free Sate	4	1
Gauteng	21	118
KwaZulu-Natal	3	14
Limpopo	6	5
Mpumalanga	2	1
North West	1	3
Northern Cape	6	1
Western Cape	14	50
Not provided	0	2
Total	**66**	**197**

It is evident from the figures in Table 1 that approximately 92% of the pilots, who completed the questionnaire, represent Gauteng, the Western Cape, and Kwazulu-Natal. The remaining pilots, approximately 8%, represent less than 10 pilots from

each of the other six provinces. With regard to the ATCs who completed the questionnaire, Table 1 indicates that approximately 67% of the ATCs represent Gauteng, the Western Cape and the Eastern Cape, approximately 18% represent Limpopo and the Northern Cape, and approximately 15% represent the Free State, KwaZulu-Natal, Mpumalanga and North West.

The respondents' mother tongues (i.e. their first languages – L1s) are presented in Table 2.

Table 2: Mother tongue (L1s) of ATCs and Pilots

Mother tongue (L1)	ATCs	Pilots
Afrikaans	20	71
Dutch	0	1
English	24	112
German	0	4
IsiXhosa	4	0
IsiZulu	2	0
Northern Sotho	2	1
Setswana	2	1
Shona	2	0
Siswati	2	0
Sesotho	1	0
Spanish	1	0
Xitsonga	2	0
Not provided	4	7
Total	**66**	**197**

Table 2 indicates that the majority of pilots and ATCs who completed the questionnaire, have English or Afrikaans as their mother tongue: among the ATCs, 66,6% indicated English or Afrikaans; among the pilots, 92% indicated English or Afrikaans.

Responses to the questions regarding language of education are presented in Table 3.

Table 3: Education language of ATCs and Pilots

Education language	ATCs	Pilots
Afrikaans	10	45
English	53	149
German	0	1
Spanish	1	0
IsiXhosa	1	0
Not provided	1	2
Total	**66**	**197**

Table 3 indicates that the majority of ATCs (80%) and pilots (76%) received (most of) their education in English, and a further 15% of ATCs and 23% of pilots received their education in Afrikaans.

The responses regarding non-aviation-related qualifications are presented in Table 4 for the pilots and in Table 5 for the ATCs.

Table 4: Age and non-aviation qualifications of pilots

Pilots	Total	Younger than 30	30-39	40-49	50-59	60 and older
Gr 12	74	15	18	16	13	12
Diploma/Certificate	51	1	7	10	21	12
Bachelor degree	56	3	12	8	20	13
Master's degree	13	0	3	3	5	2
Doctoral degree	3	0	0	2	1	0
Total	**197**	**19**	**40**	**39**	**60**	**39**

Table 4 indicates that 50% of the pilots younger than 50 years have Grade 12 as highest qualification, while 54% of the pilots older than 50 have a Bachelor's degree.

It is interesting to note, though, that 13 of the pilots have a Master's degree and an additional 3 have a doctoral degree.

Table 5: Age and non-aviation qualifications of ATCs

ATCs	Younger than 30	30-39	40-49	50-59	60 and older
Gr 12	23	9	4	1	1
Diploma/Certificate	4	6	6	2	0
Bachelor degree	1	5	1	0	0
Master's degree	1	2	0	0	0
Doctoral degree	0	0	0	0	0
Total	**29**	**22**	**11**	**3**	**1**

Table 5 indicates that the majority (58%) of the ATCs have Grade 12 as highest qualification, while 27% of the ATCs have a Diploma or Certificate as highest qualification. It is interesting to note, though, that 7 (11%) of the ATCs have a Bachelor's degree and an additional 3 have a Master's degree.

3.2.2.2 Aviation-related information

Air traffic control service centres at airports have different staff members who perform different functions. During the researcher's visits to two air traffic control towers (in Gauteng) in April 2012, the different functions were explained as follows:

Tower positions are divided into flight data/clearance delivery and other administrative responsibilities, i.e. ATC-assistant, briefing and management; ground control (i.e. tower controllers who issue instructions and authorisations for all aircraft and vehicle movements on the airport other than on the active runways); local controllers, known by pilots as "tower" (who issue take-off and landing instructions and clearances and authorise aircraft and vehicle movement on or across the active runways of the airport); and area controllers (who are responsible for aircraft at higher altitudes and for larger sectors of airspace with or without radar). Approach

controllers control a local airspace above several airports that could be grouped with Area for simplicity, as the distinction is not very important.

Table 6 shows how many ATC-respondents fulfil each of the abovementioned functions in the air traffic control tower, as well as the number of years of experience in fulfilling that function.

Table 6: Type of ATC and experience in years

ATC (Function and highest qualification in air traffic control)	Total	ATC-assistant, briefing, management	Tower	Approach	Area
Less than two years	13	1	9	2	1
Two to five years	16	2	9	5	0
Five to 10 years	15	1	4	10	0
More than 10 years	22	2	3	12	5
Total	**66**	**6**	**25**	**29**	**6**

The numbers in Table 6 indicate that in the group of ATCs who completed the questionnaire, approximately 56% has more than five years' experience in fulfilling their current function, and 33% of the total number of ATCs even has more than ten years' experience. In the researcher's opinion, this means that the ATCs are suitable respondents for the study, as their perceptions on language and communication-related issues are based on experience.

Table 7 indicates that 62% of the ATCs who completed the questionnaire, work in Air Traffic Service Units (ATSUs) where there is international traffic, which indicates the larger scale and complexity of operations that need to be performed, compared to a smaller airport where there is no international traffic.

Table 7: ATCs in service units with international traffic

ATCs (International Traffic)	Total
Yes	41
No	24
Not provided	1
Total	**66**

Turning to the pilots who completed the questionnaire, Table 8 shows how many of each type of pilot participated and how many flying hours they had completed.

Table 8: Type of pilots and total flying hours

Pilots	Total	Student	Private	Part-time professional	Full-time professional
Less than 200 hours	20	7	11	2	0
200-1 000 hours	26	0	22	1	3
1 000-5 000 hours	49	0	11	13	25
More than 5 000 hours	102	0	1	5	96
Total	**197**	**7**	**45**	**21**	**124**

The most significant numbers in Table 8 are the following: Of the total of 197 pilots who completed the questionnaire, 121 are full-time professional pilots with more than 1 000 flying hours (most even more than 5 000 hours) in their log books. This means that 61% of the participating pilots are well-qualified, highly experienced pilots who fly for a living. Another 18% represent private and part-time professional pilots with 2 000 to 5 000 hours of flying experience. As with the ATCs, the researcher is of the opinion that the pilots constitute a suitable group of respondents for this study, as their responses to the language and communication-related issues are based on extensive experience.

The pilots' qualifications and ratings are presented in Table 9 below.

Table 9: Qualifications and ratings of pilots

		Instrument rating		Instructor			
License	**Total**	**Single-engine**	**Multi-engine**	**Gr I**	**Gr II**	**Gr III**	**Micro/NPL**
ATPL	117	0	115	7	35	6	1
CPL	23	9	10	0	8	4	0
PPL/MPL/NPL	48	3	2	0	0	0	5
Student pilot	7	0	0	0	0	0	0
Not provided	2	1	1	2	0	0	0
Total	**197**	**13**	**128**	**9**	**43**	**10**	**6**

Each pilot holds one or more of the following licenses, ATPL being the highest qualification: ATPL - Airline Transport Pilot License; CPL – Commercial Pilot License; PPL – Private Pilot License; MPL – Micro-light Pilot License; NPL – National Pilot License (micro-light aircraft, gyrocopters). Table 9 indicates that approximately 60% of the pilots who completed the questionnaire are highly qualified (i.e. Airline Transport Pilots).

For some clarity, a pilot can add different ratings to his/her license, i.e. a pilot who obtained a PPL can do further training and add an instrument rating (flying only with the instruments in the plane and not visual flying) and a night rating (licensed to fly after the sun has set), but a Commercial Pilot, for example, must have a night rating in order to obtain a CPL. Approximately 24% of them also have an instructor rating, meaning that they can provide flight instruction for student pilots. Like the pilots' flying hours (Table 8), the pilots' qualifications and ratings indicate that they are well-qualified and suitable to participate in the study.

Table 10 indicates the type of aircraft that the pilots have trained on or are still receiving training on.

Table 10: Type of aircraft pilots have trained on or still receive training on

Training	Total	Aeroplane	Helicopter	Other (Gyro/Trike/Glider)
ATPL	117	106	12	2
CPL	23	21	3	0
PPL/MPL/NPL	48	44	1	8
Student pilot	7	6	0	1
Not provided	2	2	1	0
Total	**197**	**179**	**17**	**11**

As can be seen in Table 10, most of the pilots who completed the questionnaire, have received and/or are still receiving training on aeroplanes, while a small group of pilots with ATPLs and CPLs, also ventured into flying helicopters.

Table 11 provides information regarding the types of aircraft flown at least once a month.

Table 11: Number of pilots flying each type of aircraft at least once a month

Aircraft	Single-engine piston	Multi-engine piston	Turboprop	Jet	Helicopter	Gyrocopter/Trike/Glider
No. of pilots	56	1	19	68	7	4

Single-engine piston aircraft, multi-engine piston aircraft, turboprops and jets are predominantly multi-engine, but not necessarily. Table 11 therefore indicates that 88 of the pilots fly multi-engine aircraft at least once a month and 56 of them fly single-engine aircraft at least once a month. Seven pilots fly a helicopter at least once a month and four fly gyrocopters/trikes/gliders once a month.

The researcher concludes the section on the respondents with the number of flights pilots typically fly each month (see Table 12), as well as how often the pilots do flights beyond South African borders (see Table 13).

Table 12: Number of flights per month

Flights per month	Less than 4	4 to 12	13 to 20	More than 20	Not provided	Total
No. of pilots	41	62	31	62	1	**197**

Table 12 indicates that approximately 32% of the 197 pilots fly more than 20 flights per month, while another 32% do four to 12 flights per month, approximately 16% do 13 to 20 flights per month, and approximately 21% do less than four flights per month.

Of the pilots who completed the questionnaire, approximately 78% fly four or more times per month (i.e. approximately once a week), which indicates that the majority of pilot respondents in this study receive enough exposure to air traffic control communications in order to provide sensible responses to the questions on language and communication in aviation.

Table 13: Flights beyond South African borders

Flights beyond SA's borders	Never	At least once a year	At least once a month	At least once a week	Not provided	Total
No. of pilots	49	45	47	55	1	**197**

Table 13 indicates that approximately 28% of the pilots in the study fly beyond South African borders at least once a week, approximately 24% fly beyond South African borders at least once a month, 23% fly outside the borders of South Africa at least once a year, and approximately 25% of the group has never flown beyond South African borders. These numbers show that approximately 75% of the pilots have exposure to aviation procedures outside of South Africa.

In conclusion, the respondents in this study form a group of adequately qualified pilots and ATCs from different backgrounds, with different languages, and at different levels of exposure to aviation communication. The pilots' and ATCs' responses to questions on language and communication-related difficulties in aviation are provided and discussed in the next chapter.

3.3 Data set II: Voice recordings

The researcher paid two visits of three and four hours respectively to two airport towers in Gauteng to familiarise herself with air traffic control processes. During these visits, the researcher observed the ATCs at work, listened to the air traffic communications between pilots and ATCs and had short informal discussions with some of the ATCs in the towers.

The researcher came to the conclusion that the best way to analyse communication between pilots and ATCs with English as the shared language, is to obtain recordings of such discourse.

3.3.1 Obtaining the voice recordings

At the time that the research was being conducted, a larger research project on speech systems for unmanned aircraft was being conducted by a doctoral student at Stellenbosch University in collaboration with the Council for Scientific and Industrial Research (CSIR). The researchers collaborating on this larger project, obtained real-life voice recordings from airport towers from ATNS in South Africa. After being introduced to the details of the study that would be undertaken for this thesis, ATNS and the CSIR agreed that the researcher could use some of the recordings for the purposes of this study by entering into a contract of non-disclosure and confidentiality with the CSIR.

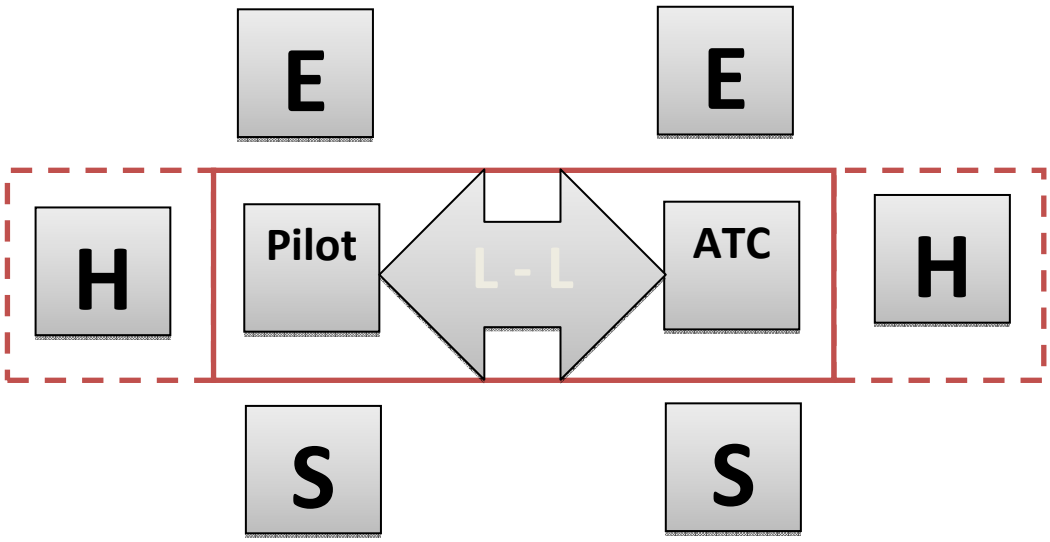
The recordings consist of two sessions at different times at each of two airports in Gauteng. A total of approximately 10 hours of discourse between pilots and ATCs was analysed for this study.

3.3.2 The analysis

As outlined in Chapter 1 of this thesis, one of the objectives of the study is to investigate Aviation English and standard phraseology in pilot-ATC communication, with specific reference to deviations from Aviation English and the use of non-standard phraseology. The researcher also investigated whether such instances of deviation from Aviation English and standard phraseology led to communication problems and if they did, whether such problems were quickly and effectively resolved to avoid hazardous situations. The researcher used part of the SHELL model, explained in Chapter 2, as basis for the analysis.

The building blocks of the SHELL model the researcher focused on, are indicated with red borders in Diagram 4 below:

Diagram 4: The building blocks of the SHELL model for the purpose of the study



For the purpose of this study, the researcher concentrated on the building block **L – L,** i.e. Liveware-Liveware or "Human-Human" interface, mainly concerned with the interface between people (and, in this study, more specifically, between pilots and ATCs). In this interface, shortcomings reduce operational efficiency and subsequently misunderstandings and errors occur.

As non-human-related factors (such as radio distortion, background noise, radio malfunction, microphone acoustics, and frequency congestion) play an important role in radiotelephony communication and continue to contribute to communication problems, the building block **L** – **H**, i.e. Liveware-Hardware or "Human-Machine" interface was also considered in the analysis. Recall that this interface is concerned with the mismatch in the human-machine relationship and the source of confusion and error and ultimately loss of communication caused by poorly designed equipment. Instances of communication problems originating at this interface were thus also included in the analysis of the voice recordings (Van Es, 2004: 32).

In the analysis of the recordings, the researcher endeavoured to identify all instances of the 12 elements which were found to be crucial in air traffic communication in the Eurocontrol study in Belgium (cf. section 2.5.1) and the John E. Volpe study in the USA (cf. section 2.5.2). The 12 elements are:

(i) read-back and hear-back errors and the type of information that is incorrectly read back;
(ii) no read-backs;
(iii) requests for repeats, increasing the workload on both pilots and ATCs;
(iv) call-sign discrepancies and/or similar call-signs;
(v) loss of communication;
(vi) malfunction of communication equipment;
(vii) radio interference and distortion;
(viii) deviations from Aviation English and standard phraseology and the use of plain English;
(ix) pronunciation;
(x) comprehension;
(xi) attitude; and
(xii) frequency congestion.

While the researcher listened to the recordings, instances of the elements were marked and numbered. In some cases, especially when deviations from standard phraseology occurred, or when non-technical (plain) English was used, the researcher transcribed the relevant utterances for further reference.

This analysis also served as an effort to cross-check the results with the results on language and communication-related factors the pilots and ATCs named (in Data Set I) as the main causes for communication problems in air traffic control. The results of the analysis of Data Sets I and II are reported and discussed in Chapter 4.

Chapter 4: Results and Discussion

4.1 Introduction

The results of this study are provided in two sections. The first section (4.2) contains the results of the language- and communication-related questions in the questionnaire. It presents the attitudes of the participants (pilots and ATCs) towards English as shared language in aviation, their experiences of communication problems in aviation (language-related and non-language-related), their opinions of whether language-related communication problems can lead to hazardous situations and fatal accidents and, lastly, how they rate the general English language proficiency of the pilots and ATCs in South Africa. The results also show whether pilots and ATCs in South Africa support language proficiency standards and testing for pilots and ATCs.

The second section (4.3) reports the results of the analysis of approximately 10 hours of real-life voice recordings of pilot-ATC communications and provides examples of instances where the researcher could identify deviations from Aviation English and other air traffic control elements which could potentially lead to communication problems (cf. the 12 elements listed in section 3.3.2).

4.2 Language and communication items on the questionnaire

Table 14 below summarises the participants' responses to the eight language- and communication-related items on the questionnaire (cf. section 3.2.1 and Appendix C). In the first column of the table, the item is provided together with the response options available to the participants. Columns 2 and 3 indicate the number and corresponding percentage of ATCs and pilots, respectively, who chose each of the response options. Column 4 provides these figures for the ATCs and the pilots taken together, i.e. for the entire group of participants.

Table 14: Language and communication items (questionnaire)

Item on questionnaire	ATCs n = 66		Pilots n = 197		Total n = 263	
1. Number of times in threatening situations where communication problems contributed to the situation.		%		%		%
Never	17	26	64	32	81	31
One to three	15	23	70	36	85	32
Three to ten	16	24	26	13	42	16
More than 10	18	27	35	18	53	20
I don't understand the question	0	0	1	1	1	0
No option chosen	0	0	1	1	1	0
Total	**66**	**100**	**197**	**100**	**263**	**100**
2. Level of confidence that communication problems among pilots and ATCs are quickly resolved.		%		%		%
Not confident	11	17	20	10	31	12
Fairly confident	26	39	68	35	94	36
Confident	20	30	62	31	82	31
Very confident	9	14	44	22	53	20
I don't understand the question	0	0	1	1	1	0
No option chosen	0	0	2	1	2	1
Total	**66**	**100**	**197**	**100**	**263**	**100**
3. Category most often the cause for communication problems among pilots and ATCs.		%		%		%
Non-language-related factors						
Attitude	23	35	79	40	102	39
Non-compliance with instructions	33	50	52	26	85	32
Nervousness	25	38	47	24	72	27
Lack of experience	43	65	119	60	162	62
Language-related factors						
Pronunciation	35	53	133	68	168	64
Structure	7	11	29	15	36	14
Vocabulary	21	32	44	22	65	25
Fluency	21	32	69	35	90	34
Comprehension	39	59	90	46	129	49
Interaction	9	14	37	19	46	17
Other factors						
Radio distortion and background noise	39	59	105	53	144	55
Radio malfunction	29	44	13	7	42	16
Frequency congestion	28	42	114	58	142	54

4. The possibility that language-related communication problems can cause fatal accidents and serious incidents.		%		%		%
Impossible	0	0	0	0	0	0
Unlikely	3	5	13	7	16	6
Possible	32	48	108	55	140	53
Likely	29	44	72	37	101	38
I don't understand the question	1	2	1	1	2	1
No option chosen	1	2	3	2	4	2
Total	**66**	**100**	**197**	**100**	**263**	**100**
5. Support for English language proficiency standards and testing for pilots and ATCs.		%		%		%
Strongly oppose	0	0	1	1	1	0
Somewhat opposed	0	0	6	3	6	2
Neutral	3	5	14	7	17	6
Somewhat in favour	9	14	32	16	41	16
Strongly in favour	53	80	142	72	195	74
No option chosen	1	2	2	1	3	1
Total	**66**	**100**	**197**	**100**	**263**	**100**
6. English as lingua franca in a multilingual aviation community nationally and internationally.		%		%		%
Disagree	0	0	3	2	3	1
Neutral	4	6	1	1	5	2
Agree	61	92	189	96	250	95
I don't understand the question	1	2	2	1	3	1
No option chosen	0	0	2	1	2	1
Total	**66**	**100**	**197**	**100**	**263**	**100**
7. English language proficiency of pilots and ATCs in South Africa.		%		%		%
Poor	6	9	8	4	14	5
Adequate	22	33	62	31	84	32
Good	35	53	105	53	140	53
Excellent	3	5	21	11	24	9
No option chosen	0	0	1	1	1	0
Total	**66**	**100**	**197**	**100**	**263**	**100**
8. Number of times radio communication problems were experienced.		%		%		%
Never	4	6	21	11	25	10
One to three	12	18	65	33	77	29
Three to ten	13	20	37	19	50	19
More than 10	37	56	73	37	110	42
No option chosen	0	0	1	1	1	0
	66	**100**	**197**	**100**	**263**	**100**

As Table 14 indicates, the overwhelming majority of ATCs and pilots (95%) seem to agree that English should be the lingua franca in aviation nationally and globally (item 7), and 74% of the participants are strongly in favour of English language proficiency standards and testing for pilots and ATCs (item 6). Approximately 53% of pilots and ATCs rate the general English language proficiency of the people in their profession in South Africa as “good”, an additional 32% rate this proficiency as “adequate” (item 8). Only 5% feel that the proficiency is inadequate.

The majority of pilots and ATCs (53%) indicated that it is possible that language-related communication problems can contribute to fatal accidents and serious incidents, and an additional 38% of the participants even indicated that this is likely, rather than just possible (item 5). However, the overwhelming majority (87%) of participants also believe that communication problems between pilots and ATCs in South Africa are quickly and easily resolved to avoid accidents: 36% of pilots and ATCs feel fairly confident that this is the case, 31% feel confident, and 20% feel very confident (item 3).

It is interesting to note the discrepancy between participants’ responses to items 1 and 2, i.e. the number of times that participants experienced radio communication problems versus the number of times they felt that they were in threatening situations (partly) as a result of communication problems: 67% of the pilots indicated having experienced radio communication problems while flying and 74% of the ATCs indicated that they have experienced radio communication problems doing air traffic control. It is unsurprising that ATCs reported a higher incidence of radio communication problems than pilots, given that, by nature of their profession, the average ATC spends much more time in radio communication than the average pilot. However, when it comes to the number of times participants reported having been in threatening situations because of communication problems, 27% of the ATCs, and only 18% of the pilots indicated that they had experienced this more than 10 times (36% of the pilots indicated that they had experienced this only 1 to 3 times). The higher reported incidence for ATCs could again be attributed to the fact that, by nature of their profession, the average ATC deals with significantly more flights than the average pilot does on a daily basis; a pilot can only do a certain number of hours

per day, while an ATC spends all of his/her working hours facilitating a large number of different flights.

Furthermore, the figures in the table related to items 1 and 2 show that pilots and ATCs do not experience radio communication problems as necessarily leading to threatening situations – see the much lower reported incidence for threatening situations (item 2) than for radio communication problems (item 1). This result is consistent with the participants' confidence that communication problems between pilots and ATCs are quickly and easily resolved (item 3).

Turning to item 4, participants were asked to indicate all of the factors that most often cause communication problems between pilots and ATCs. The non-language-related factor most frequently indicated as contributing to pilot-ATC communication problems by both the ATCs and the pilots, was lack of experience: 65% of ATCs and 60% of pilots indicated this factor. The next most frequently indicated factor was non-compliance with instructions for the ATCs (50% of the group indicating this factor) but attitude for the pilots (40% of the group indicating this factor). The two language-related factors most frequently indicated by both ATCs and pilots were pronunciation (indicated by 53% of ATCs and 68% of pilots) and comprehension (indicated by 59% of ATCs and 46% of pilots). In the category of "other factors", radio distortion and background noise was indicated by 59% of ATCs and 53% of pilots, and frequency congestion was also frequently indicated by ATCs (42% of this group) and pilots (58% of this group). Interestingly, whereas 44% of ATCs also indicated radio malfunction, only 7% of pilots indicated this factor. Taking the participants' responses to this item together, we can therefore conclude that, according to both pilots and ATCs, lack of experience, non-compliance with instructions, attitude, pronunciation, comprehension, radio distortion, background noise, and frequency congestion are the most prominent factors in communication problems between pilots and ATCs.

4.3 Voice recordings

4.3.1 Introduction

The researcher listened to approximately 10 hours of pilot-ATC communication. The first set of recordings, from Airport X (approximately 5 hours) included approximately 70 different aircraft (i.e. the researcher was able to identify 70 different aircraft call-signs) and approximately 387 transmissions were made by pilots and ATCs during the recorded period. The second set of recordings from Airport Y (approximately 5 hours) included approximately 67 different aircraft, and approximately 418 pilot-ATC transmissions. The total number of aircraft involved in the complete set of voice recordings is thus 137 and the total number of transmissions[14] is 805.

4.3.2 General observations

Four of the twelve elements identified as crucial in air traffic control (cf. sections 2.5 and 3.3.2), could not be investigated with the data that the researcher had at her disposal: comprehension and attitude (human factors) and equipment malfunction and frequency congestion (hardware). As the researcher had access to voice recordings, removed from the real-life situation, and as she was not present in the tower at the time of the transmissions, there was no possibility to observe the ATCs' reactions and hear additional commentary, or to ask questions to verify such elements as lack of comprehension and attitudes of both pilots and ATCs.

The ATNS record voice transmissions only and the periods where there was no speech means there were no transmissions. The researcher therefore was not able to determine instances of loss of communication (unless there was evidence of pilots reporting to the ATC that there had been a problem and communication had been restored - see 4.3.5 below), instances of malfunction of radio equipment, or other hardware factors such as frequency congestion. In the end, the researcher was able to investigate only eight of the twelve elements, namely read-back and hear-back errors, no read-backs, requests for repeats, call-sign discrepancies and/or similar

[14] Every instance of turn-taking between a pilot and an ATC, regardless of who made the first contact, was counted as a transmission.

call-signs, loss of communication, deviations from Aviation English and standard phraseology, pronunciation, and radio interference and distortion. The findings with respect to each of these elements are reported in sections 4.3.3 to 4.3.8 below.

4.3.3 Read-backs and hear-backs

The researcher was able to identify 24 instances of read-back and hear-back errors while listening to the recordings of both airport towers. These instances of read-back/hear-back errors involved the following: read-back errors, hear-back errors, no read-backs and requests for repeats. Some representative examples are provided and briefly discussed below.

Example 1

ATC: ……	*XXX*[15] *Cleared inbound at five thousand feet, QNH one zero two five. Copy operate above Nyala and report at Kudu.*[16]
Pilot: ……	*Confirm Nyala.*
ATC: ……	*XXX Negative. Operate Nyala, then confirm Kudu. Keep a look-out for traffic inbound at 5 100 ft.*
Pilot: ……..	*5 100 feet and copy traffic, XXX.*

In Example 1, the pilot did not give a complete read-back of the full instruction and omitted *QNH one zero two five*, which is important, as it signals altitude. This is thus an example of an incorrect read-back.

Example 2

ATC: ……..	*YYY Cleared inbound for a long final approach at four thousand six hundred feet, QNH one zero two five.*
Pilot: ……	*Report four miles for approach at five thousand six hundred. QNH one zero two four.*

[15] As aircraft are identifiable by their call-signs, these have been replaced by random letters (such as "XXX" in Example 1) in order to ensure anonymity.
[16] The names of airports and places in the examples have been substituted with fictitious names like Nyala, Kudu and Springbok.

ATC: …… *YYY Correction. Long final approach and maintain five thousand six hundred feet, YYY. QNH one zero two four.*

Example 2 above illustrates that the ATC initially provided the wrong QNH (*one zero two five)*. The pilot read this back as (*QNH one zero two four),* which involves a read-back error but happened to be the correct QNH. The ATC then confirmed this QNH. This example thus contains incorrect information provided by the ATC, as well as an incorrect read-back by the pilot – although the pilot's QNH turned out to be correct, it was not an accurate read-back of the information provided by the ATC. The pilot also read back a wrong approach the first time using *approach* instead of the correct *long final approach*. The ATC signalled this with the word *Correction* and repeated the correct approach.

Example 3

ATC: …… *ZZZ cleared inbound at five thousand six hundred feet. QNH one zero two five. Report left down-wind Runway one one.*

Pilot: ……... *QNH one two zero five, um…..um….cleared for……um……..um report down-wind….one one.*

ATC: …… *ZZZ maintain five thousand six hundred feet. Report left down-wind runway one one. Circuit is active.*

Pilot: …… *(Silence)*

Example 3 is an example of a "no read-back" error. After the ATC's first set of instructions, the pilot attempted a read-back, but only managed a partial read-back which was not entirely coherent. The ATC repeated the first set of instructions but this was met with silence. Contact with the tower was re-established several minutes later when the pilot was ready to turn base for the final approach. It seems that this particular pilot struggles with read-backs as illustrated in the next example.

Example 4

Pilot: ……	X tower, ready to turn base.
ATC: ……	*ZZZ, turn base, descend as required. Report final approach runway one one. Number two. Number one is a Cherokee on late base.*
Pilot: ……...	*…is almost at…….uh….uh…uh…. right base…….ag, left base.*

It is clear from Examples 3 and 4 that the pilot at no time provided a correct, coherent and complete read-back. Although the pilot eventually made a safe landing at the airport, this interaction cannot be deemed appropriate since a crucial part of pilot-ATC communication, namely a clear, accurate and complete read-back, was not provided. In addition to read-back errors, the pilot also did not adhere to standard reporting syntax, e.g. no call-sign.

Example 5

Pilot: ……	X tower, ready to turn base and will report final approach. No three.
ATC: ……	*ABC, negative. Number two. Number three is a Cessna at late base turning final approach.*
Pilot: ……...	*Number two.*

The situation then changed with regard to the order of the aircraft coming in to land and the communication continued as follows:

ATC: ……	ABC, continue approach for runway one one, number two. Number one is on short final.
Pilot: ……	Uh…..uh….copy that…..cleared for touch and go…..runway one one.
ATC: ……	*Negative, ABC. Continue approach, sir.*
Pilot: ……...	*Uh….continue approach……sorry…..apology for that.*

In the example above (Example 5), the pilot did not make use of standard phraseology at all and the read-backs were incomplete and erroneous. There is a difference between *continue approach* and *cleared for touch and go*, as there are

rules for the separation of aircraft at airports in the airspace and on the ground.

The ATC pointed out the pilot's error *(Negative)* and repeated the correct instruction, which was to *continue approach*, probably because there was another aircraft at short final approach and cleared to land. The ATC had to communicate and point out the error to comply with the separation rules between aircraft.

Example 6

ATC: ……	*DEF, cleared for take-off. Report outbound over Springbok at six thousand feet.*
Pilot: ……	*Five thousand feet. Correction, six thousand feet.*

In this example, and in other similar instances, the pilot corrected himself while doing the read-back to the ATC. The immediate use of the word *Correction* is an effective strategy used by pilots and ATCs to quickly and effectively eliminate any misunderstanding by correcting themselves, before the communication goes further and was often heard while listening to the voice recordings.

Example 7

ATC: ……	*GHI, cleared for runway zero six. Number two. Number one is on left base.*
Pilot: ……	*(Radio distortion and noise)* *X tower, say again, please.*
ATC: ……	*GHI, cleared for runway zero six. Number two. Number one on left base.*
Pilot: ……	*Runway zero six. Number two.*

Radio distortion and noise could have been the reason why the pilot could not hear the ATC's instruction in this example, but in this instance two transmissions occurred at the same time, something which the ATC indicated to the pilot of aircraft GHI by saying the words *double transmission.* During the course of this communication, the ATC also issued instructions to another aircraft with a very similar call-sign, but pronounced the letters very clearly, indicating instances of double transmissions and repeating instructions to the one pilot when this was requested. In this way, the

communication problems were successfully and effectively resolved.

Example 8

ATC: ……	*JKL, please report number of people on board.*
Pilot: ……	*(Silence)*
ATC: ……	*JKL, please report number of people on board.*
Pilot: ……	*(Several seconds later) Uhhhhh…. One crew plus two on board.*

In the final example of read-back/hear-back errors above (Example 8), the pilot should have concluded the communication with the aircraft call-sign to indicate that the correct aircraft responded to the ATC's call. No responses, no read-backs and partial read-backs could be the result of equipment failure, radio distortion and noise or pilots pre-occupied with the tasks at hand in the cockpit. All of these things could lead to problematic situations if the communication does not flow from the initial call and instructions, followed by a full read-back and the conclusion with the aircraft's call-sign.

With regard to read-backs, hear-backs, no read-backs and requests for repeats, the researcher came to the conclusion that the frequency of instances with regard to read-back errors, hear-back errors, no read-backs and requests for repeats is relatively low and in the case of requests for repeats, the instructions were successfully heard and repeated by the pilot after they were repeated by the ATC. Only 3,7% of the total of approximately 805 transmissions involved read-back/hear-back problems and requests for repeats. Pilots almost always provide (complete and accurate) read-backs to the ATC's instructions and ATCs repeat their instructions upon request.

4.3.4 Similar call-signs

In the two groups of recordings, the researcher could identify 10 instances where the call-signs of aircraft were very similar and where this could have presented problems in read-backs or during consecutive transmissions not far apart from each other

during the flow of the air traffic control communication. As explained in section 4.3.3/footnote 16, due to the fact that pilots and aircraft are identifiable through call-signs, i.e. registration numbers of the aircraft, and must remain anonymous, the real call-signs of the aircraft cannot be provided here, but the researcher created similar call-signs to serve as examples to illustrate the point.

Call-signs like HVJ and HJV (Hotel Victor Juliet and Hotel Juliet Victor) or VIO and VLO (Victor India Oscar and Victor Lima Oscar), especially when spoken at a very fast speech rate, can cause discrepancies, as well as confuse pilots and lead them to accept the wrong set of instructions, or result in read-back and/or hear-back errors. The researcher found that the ATCs in the recordings specifically pronounced similar call-signs very clearly and spoke at a slower speech rate in such instances to make pilots aware of the similar call-signs.

An interesting phenomenon is that when ATCs speak slowly and clearly, pilots follow suit, and vice versa. Therefore, in the instances where similar call-signs posed potential communication problems, ATCs (and the pilots involved) used a slower speech rate and clear pronunciation to avoid confusion, and no evidence of call-sign discrepancies, or evidence of confusion in either read-backs or hear-backs were found. The potential communication problems that could be caused by similar aircraft call-signs thus seem to be something that ATCs and pilots are aware of.

4.3.5 Loss of communication

Although it was difficult for the researcher to determine the exact cause of loss of communication in the recordings, it was possible to identify approximately five instances of communication loss.

After an ATC has issued instructions, pilots are required to read back the instructions or indicate that they heard the information provided by the ATC. In two instances of loss of communication, the start of the read-back is heard followed by severe radio distortion and then silence. As the researcher is familiar with the tower and observed similar situations in her visit to the tower, the fact that the ATC did not repeat the instruction in order to elicit a read-back from the pilot, is most probably an indication

that the ATC had the aircraft in sight and could visually observe that the pilots were in compliance with the instructions. The loss of communication had therefore not been critical at that moment.

In another instance, the ATC could not establish communication with an aircraft lining up to take off and after a while, the pilot reported that radio communication had been restored by using the words *XXX report recovered*, which indicated to the ATC that transmission could continue, after which the ATC acknowledged with the words *Copy Recovered*. This sequence of events could also have been a simulated engine-failure exercise after take-off, which would then render it not related to a communication failure.

It is often the case that when a student pilot is under instruction at an airport, the instructor sometimes takes over the radio communication to relieve the student of some of the workload in the cockpit, especially when the student still lacks experience. In one such instance, the ATC issued joining and landing instructions after which no read-back was received. The ATC repeated the instructions and still no read-back was received, pointing to a situation where loss of communication was perceived from a listener's point of view. The ATC asked again whether the information had been received and after a few seconds the instructor read back the instructions. The researcher realised that it was the instructor who responded because of the identification of the aircraft by its call-sign and could therefore come to the abovementioned conclusion that the student was not able to simultaneously execute the tasks of flying the aircraft and handling the radio transmissions. Communication was restored effectively to avoid a hazardous situation, but lack of experience on the student pilot's side contributed to the loss of communication, which confirms pilots' and ATCs' perception that lack of experience is one of the causes of communication problems (cf. section 4.2).

The last instance of loss of communication occurred where the ATC failed to establish communication with an aircraft en route to the airport as there was simply no response from the aircraft in question. In an effort to determine the exact position of the aircraft, the ATC used plain English to request another pilot, also in the airport's controlled airspace, to assist by either confirming visual contact with the

aircraft or by trying to communicate with the aircraft on a different frequency, and, if possible, to report back to the tower on the position and model of the aircraft in question. After a while, the aircraft in question did establish contact with the tower but unfortunately it is not possible for the researcher to identify the exact cause of the initial loss or lack of communication.

4.3.6 Radio distortion and background noise

In the recordings made at Airport X, the researcher heard 58 instances of radio distortion and background noise that made the transmissions of pilots and ATCs unintelligible. In the recordings made at Airport Y, 62 instances of radio distortion and background noise interfered with the intelligibility of the transmissions. A total of 120 radio distortion and background noise instances means that 15% of the total number of transmissions involved such distortion/noise. This is a substantial percentage (especially when compared to the percentage of transmissions in which other types of communication problems occurred), and it confirms the pilots' and ATCs' perception that these elements are major contributors to communication problems.

4.3.7 Deviations from Aviation English and standard phraseology

The researcher identified 22 instances where plain English was used on air, or pilots deviated from standard phraseology while doing read-backs. Representative examples, grouped by similar instances, are provided below.

Firstly, a number of simplified read-backs were heard, e.g. a pilot provided the simplified read-back: *for one one* instead of the standard *cleared for runway one one*. In another instance the pilot read back only *five six* instead of the standard *five thousand six hundred feet* or as in another instance *five five* instead of *five thousand five hundred feet.* Simplifying read-backs can lead to confusion because of the fact that runways are identified with numbers in pairs of two digits, e.g. *two nine*, and if pilots do not read back the full number, it could lead to confusion with runway numbers.

Secondly, there were a number of instances where plain language was used and conversations in plain language, strictly-speaking, are not relevant to or necessary for pilot-ATC interaction. One pilot even code-switched (cf. section 2.2.2.5) by using an Afrikaans greeting and concluded the communication by saying *Lekker dag!* ('Have a nice day!'). This is, of course, an obvious deviation from Aviation English on a number of levels: it is Afrikaans, it is informal/non-standard, and it is not an appropriate closing statement. There were two instances where pilots and ATCs used phrases like *Have a nice week-end* and *Have a nice day,* after which the response came as *Thank you, you too*, as well as where a pilot said *Thank you for accommodating us* with a response from the ATC *It has been a pleasure.* At one stage a pilot had to delay his take-off due to a technical problem with the aircraft and later on apologised by saying to the ATC *Thank you and sorry for the inconvenience,* to which the ATC replied *No problem*. These expressions of politeness are not really relevant to pilot-ATC interaction, but they often occur. It is also not uncommon in an environment where flight training organisations operate at an airport and a student, familiar to the ATC, progresses through all the phases of his/her flight training, for the ATC to then say *Congratulations on your initial solo* after the student has completed his/her landing. Some people would argue that if the airport is relatively quiet with one or two aircraft in the circuit, plain language expressions, as mentioned above, should not pose a threat to communication problems; however, plain language phrases still represent non-standard phraseology and during busier times when the level of workload in the tower is much higher and the ATC has to maintain a high level of concentration, such phrases and/or conversations could clutter the frequency and waste precious time in the flow of the air traffic control. It could also lead to distractions which will be detrimental to pilots with relatively little experience, especially student pilots.

The third observation with regard to deviations from Aviation English and standard phraseology involves non-standard terms or phrases, e.g. a pilot read back *Ja, that's correct, ma'am* instead of using the standard term *Affirm;* another pilot said *Thanks, we will call you overhead the field* instead of using the appropriate phrase *will report when X is in sight* (X being the name of the airport). In another transmission, an ATC said *More speed, please.* It is not exactly clear to the researcher why the instruction

was given in this manner because if the ATC meant that the pilot should increase speed in the final approach in order to comply with aircraft separation rules, the standard phrase *increase speed for final approach* should have been used. In another instance the ATC requested the pilot to reduce altitude with the words *expedite descend.* The researcher specifically mentions this instance as the word *expedite* could present a problem for a non-native English speaker with limited English vocabulary. (Similar instances where certain words were not understood by LPR candidates, have occurred in the numerous LPR tests the researcher has conducted with pilots in the past five years.) Also, note that the ATC should have said *expedite descent* as the latter refers to the act of reducing altitude as opposed to *expedite descend,* which actually involves two separate verbs, seemingly calling for two actions, namely "to expedite" (though it is not clear what should be expedited) and "to descend". In other words, there is confusion between the words *descent* (a noun) and *descend* (a verb). Also refer to section 4.3.8, directly below, on pronunciation. "Expedite" is indeed a standard phrase, defined in the RTM. It is indispensable and there does not appear to be a simpler replacement phrase that has the same lack of ambiguity with regard to temporal and spatial rate, but care should be given to the pronunciation of *descend* and *descent* on air.

Lastly, there are cases where plain English is used for clarification purposes or for specific requests. At one stage, an ATC issued instructions to a pilot to report when crossing the N1 highway. The pilot requested clarification and the pilot and ATC subsequently engaged in a (rather informal) conversation regarding the N1. The ATC's initial instruction was *Report at crossing the November one highway, QNH one zero two four, five thousand six hundred feet.* The pilot expressed confusion and requested clarification by saying *Uhh, ma'am. Not familiar with the November one, only with the November four highway. Could you please give me a heads-up there, please?* The ATC responded with *Sir, the November one is a big highway in a south-north direction. It is a double highway, you can't miss it. Currently, three miles to the eastern side of your position.* The pilot indicated that he understood, saying *Thank you, ma'am.* Also recall the instance referred to in section 4.3.5 above, where an ATC was having trouble establishing communication with an aircraft. In this case the ATC requested a pilot in another aircraft to assist in identifying the aircraft that could not be reached, by asking *JKL, I can't get the traffic at seven thousand seven*

hundred feet. If you have the traffic in sight, is it possible to tell me what type of aircraft it is and what the registration is?

In conclusion, the exchanges mentioned above mostly involved plain English rather than standard phraseology, but do not necessarily involve non-compliance with ICAO regulations, given that these regulations clearly state that pilots and ATCs should be able to use plain English when necessary (cf. section 2.3.3.2), and plain English might well be necessary exactly in cases such as these, where clarification is requested. The statements mentioned in section 2.3.3.2.2 come to mind, with reference to the requirement that pilots and ATCs should have the ability to speak in a manner that is clear and easy to understand, to compose meaningful sentences or messages, to use correct words and phrases that match the setting, to respond, narrate events or describe situations naturally, to understand and follow instructions without difficulty, to ask and answer questions, and to engage in two-way dialogue without difficulty. It is not always possible to communicate using only Aviation English and standard phraseology and, therefore, pilots and ATCs need to be proficient enough to use plain English in an ambiguous, clear and concise way.

The last element that is briefly discussed below concerns accents of non-native English speakers and pronunciation.

4.3.8 Pronunciation

The researcher was able to identify approximately 16 instances of strong non-native English speaker accents that involved speakers with Afrikaans, an African language, French or Italian as their L1. However, there was no evidence that these different accents interfered in any way with ease of understanding or the pronunciation of letters and numbers.

Two other interesting observations were made with respect to pronunciation. Firstly, when aircraft call-signs contain the letter X – pronounced *X-ray,* it invariably becomes almost entirely unintelligible when pilots and ATCs maintain a very fast speech rate. An example is where the X is in the middle of the call-sign, e.g. *Oscar X-ray Golf*. When the call-sign is pronounced at a very fast speech rate, it could

easily be confused with OSG - *Oscar Sierra Golf*. Secondly, when a letter appears more than once in an aircraft call-sign, e.g. OOG – *Oscar Oscar Golf,* pilots and ATCs tend to pronounce the letters so quickly one after the other that a listener only hears a part of the call-sign. The researcher experienced this numerous times while listening to the recordings, and in many instances, the ATCs on duty had to request the pilots to repeat their call-signs in an intelligible manner. Pilots and ATCs should take care not to speak too fast and to pronounce important information, like call-signs, clearly and intelligibly.

The last instance of pronunciation the researcher heard is where an ATC pronounced the word *descend (descend as required)* as *decent* ([di:s(ə)nt]), the adjective meaning "respectable or acceptable", instead of *descend* ([dɪ'send]) meaning "go or come down". The researcher is of the opinion that homonyms could pose a problem in radiotelephony communication and special care should be taken to ensure correct pronunciation as well as comprehension.

4.4 Conclusion

In conclusion, the results of the questionnaire showed that approximately 59% of the ATCs who participated in the study named pronunciation, as well as radio distortion and background noise as major factors in communication problems. Of the pilots, 67% named pronunciation as a language-related factor in communication problems and the majority of pilots (58%) indicated that frequency congestion is a significant contributing factor in communication problems between pilots and ATCs.

If we look at the discussion in section 4.3 on the eight elements the researcher was able to identify while listening to the recordings, we can safely say that, overall, the results of the questionnaire correlate with the situation in real-life air traffic control communication and that the effort of triangulation proved successful. Unfortunately, the element "lack or experience" could not be investigated in depth as it was impossible to determine which pilots and aircraft in the recordings were relatively new to the environment, and only one example (cf. section 4.3.5) of an instructor taking over from a seemingly inexperienced student pilot could be described.

The last chapter of this thesis, Chapter 5, consists of the researcher's conclusions, as well as some recommendations and suggestions for future research, and a brief discussion of the limitations of the research reported in this thesis.

Chapter 5: Conclusion

To conclude the thesis, this chapter provides some general conclusions, evaluates the limitations and strengths of the research reported in this thesis, and finally makes some recommendations and suggestions for future research.

5.1 Linking objectives and outcomes

The first and third objectives of the study were, respectively, to investigate the perceptions of pilots and ATCs in South Africa of the role of language in air traffic communication, and to investigate the use of Aviation English in pilot-ATC communications in South Africa, including elements that cause communication problems in radiotelephony communications. The results of the questionnaire indicated that the majority of pilots and ATCs believe that language-related problems can cause fatal accidents and serious incidents. Pilots and ATCs in South Africa do experience threatening and potentially hazardous situations as a result of communication problems; however, they are confident that communication problems are resolved quickly and successfully in order to avoid accidents. The analysis of the voice recordings correlated with the pilots' and ATCs' perceptions: in spite of communication problems (language-related and non-language-related) occurring in South African airspace, pilots and ATCs have strategies in place to resolve them effectively and they are also able to use plain English, supplementary to Aviation English and standard phraseology, to negotiate understanding and meaning.

The second objective of the study was to determine South African pilots' and ATCs' perspectives on English as lingua franca in aviation, and English language proficiency standards and testing for pilots and ATCs. South Africa is a multilingual country with a plethora of different L1s. As discussed in chapter 2, English is a lingua franca globally and in South Africa, and it has also become the lingua franca in airspace. The majority of pilots and ATCs who participated in this study indicated that they agree with English as the shared language in aviation around the world. Most of the respondents indicated that the English language proficiency of South African pilots and ATCs is satisfactory and that they support English language

proficiency standards and testing, as required by ICAO. In the voice recordings, different accents were recognised, but they did not seem to have any effect on communication. In fact, overall, the communications during the course of 10 hours proved to be intelligible and clear. The results showed that only 3,7% of a total of approximately 805 transmissions contained read-back/hear-back errors. A substantial number of radio distortions and background noise (15% of the total transmissions that were heard) interfered with the intelligibility of the transmissions. A further 22 instances (out of the 805 transmissions, i.e. approximately 3%) contained deviations from Aviation English and standard phraseology and/or plain English.

5.2 Strengths and limitations

A definite strength of this study was the fact that I could build on previous related studies that have been conducted elsewhere in the world (cf. section 2.5), specifically in terms of their research design and methodology. Specifically, the SHELL building block model (cf. section 2.5.1) proved to be valuable for the analysis of real-life voice recordings, especially in terms of the distinguishing features of human-human interaction, on the one hand, and human-hardware and human-software interaction, on the other hand. The technology and equipment involved in pilot-ATC communication cannot be separated from language-related human factors and the two building blocks will therefore always have to be studied in tandem.

The fact that I had the collaboration of an experienced pilot, Designated Flight Examiner for the CAA, and owner of a flying school with an extended and established network in the aviation industry and employed at the CSIR, strengthened and supported my efforts to conduct this study. Furthermore, the fact that I am an accredited LPR examiner for the CAA in South Africa who has conducted approximately 300 LPR interviews, provided a solid foundation for the discussion and research on Aviation English, standard phraseology and language proficiency testing standards. The visits to the airport towers brought valuable perspectives in terms of air traffic control services and how air traffic is managed at different airports.

I followed a qualitative descriptive approach and although the first set of data collected (by means of an online questionnaire) elicited an overwhelming response from both pilots and ATCs, I do not regard the group of participating pilots as representative of the entire pilot community in South Africa, which is, of course, one of the limitations of the study. However, the group of ATCs who completed the questionnaire can be regarded as representative of the ATC services community in the country. In an informal interview with Burger (2012), I was told that there are approximately 12 000 pilots in South Africa, and the ATNS indicated that there are approximately 300 ATCs in South Africa. Therefore, although only approximately 1,6% of South African pilots completed the questionnaire, almost a quarter (22%) of South African ATCs completed the questionnaire. Due to the scope of this project in terms of extent, time and resources, it was not possible to involve a larger group of pilots.

As this study on Aviation English in South Africa was the first of its kind, there was no previous research within the field of linguistics, specifically, to rely on. However, as the first of its kind, the study also serves to indicate some avenues for further, potentially very valuable, *linguistic* research on Aviation English and pilot-ATC communication in South Africa.

5.3 Recommendations and suggestions for further research

Research across the globe has shown that language plays a crucial role in aviation safety. Numerous serious incidents and fatal accidents have occurred where the use of English as lingua franca and interlocutors' levels of English language proficiency were minor or major contributors. I am of the opinion that ensuring sufficient levels of proficiency in English (plain English as well as Aviation English) should be high on the priority list of the SACAA's safety policies and procedures in order to ensure aviation safety in this country. One serious or fatal accident is one too many, and therefore South Africa should do whatever is necessary to ensure that all pilots and ATCs operating in South African airspace are fluent in Aviation English and plain English. The implementation of the LPR standards and testing procedures has most definitely made a significant contribution in this respect, but consider the following

information, extracted from a recent report issued by SACAA in 2012 (SACAA, 2012)[17]:

On 26 October 2010 two aircraft, a Piper and a Jabiru were conducting circuit training at Aerodrome Y. The runway was in use, and right-hand circuits were flown. The Jabiru was flown by an instructor pilot and a qualified pilot on a revalidation check-flight and the Piper was being flown by a student pilot. The student pilot had conducted three circuits with an instructor pilot after which the instructor pilot assessed the student pilot as being at a standard that would allow him to conduct further solo circuits, which required a full-stop landing so that he instructor pilot could exit the aircraft. The student pilot took-off and re-entered the circuit to conduct solo circuit training. Later, the Jabiru was cleared for final approach for a touch-and-go landing. The Piper, on base leg for a touch-and-go landing was cleared after he confirmed he had the Jabiru in sight. He was instructed to position himself as number two behind the Jabiru for final approach and touch-and-go. Shortly after the Jabiru became airborne after the touch-and-go, the two aircraft collided in midair, approximately 30 feet above the runway. The pilots of both aircraft lost control of their respective aircraft and impacted with the ground. The flight instructor in the Jabiru was seriously injured and the private pilot under instruction in the Jabiru, as well as the student pilot in the Piper sustained minor injuries.

Some of the factors said to have contributed to the accident are the following: the student pilot failed to execute an immediate go-around as instructed by the ATC; the ATC had to call the aircraft three times before the pilot acknowledged during a critical phase of the flight; the student pilot did not see the other aircraft in time to prevent the collision (loss of situation awareness); the decision by the instructor pilot to send the student pilot solo during a busy traffic period placed the student in a high workload environment (disregard for standard/safe operating procedures); and the student pilot had a low level of experience on which to base operational decisions.

The report further states the student pilot hailed from Tanzania and that he had a definite "communication barrier" as his L1 was not English. Several comments on

[17] The name of the airport, the runway number and the aircraft call-signs have been removed in order to ensure anonymity.

problematic areas were entered in the student's file, e.g. communication problems (language barrier), situation awareness, underperformance and multitasking (i.e. gets flustered during training scenarios). The student's training file also revealed problems with radio procedures and no evidence could be found of remedial actions to correct the problem. Seconds before the accident, the ATC called the student three times and he only answered after the third call. He acknowledged the instruction, but failed to execute the instruction. The investigator wrote that during an interview after the accident, the student pilot failed to understand the investigator's questions and the student had a problem expressing himself in the English language.

In the concluding findings of the report, the investigator mentions "incorrect radiotelephony procedures, which was further impaired by not being fluent in the English language" and recommends that the Flight Operations Department within the SACAA compile a circular to alert all pilots to the potential hazards of midair collisions and to emphasise the basic problems related to human causal factors. Further recommendations include research on radiotelephonic licenses; the LPR as a prerequisite for the issuing of a Student Pilot License[18]*; the implementation of a policy pertaining to the accreditation and integration of foreign student pilots for initial and advanced flight training in South Africa "to ensure eligible candidates share our airspace"; and an investigation by SACAA into ATCs' leniency towards student pilots and the influence of such leniency on flight safety.*

The report on the abovementioned accident is a combination of all the elements touched on in this thesis: English as lingua franca in aviation; language and aviation safety; human factors, such as memory, speech rate, personal limitations and fatigue; Aviation English; radiotelephony communication; pilot-ATC communication; and English language proficiency testing and standards. It is clear that all of these elements are tied together and influence each other in significant ways. Therefore, I recommend further research on the following aspects:

[18] Currently, the LPR is a prerequisite for the issuing of a Private Pilot License and is not required to obtain a Student Pilot License.

- the relationship between human factors such as memory, situation awareness, and fatigue, on the one hand, and communicative abilities, on the other hand, especially when pilots and ATCs who are non-native English speakers have to communicate in English in stressful environments with high workloads;
- English language proficiency standards and testing in the South African environment, with specific focus on the validity, reliability and application of the current LPR Testing Procedures and Regulations of the SACAA;
- the use of Aviation English and standard phraseology in the broader aviation community in South Africa by transcribing and analysing pilot-ATC communication on a larger scale than was done in this study;
- the development of guidelines and protocols for the investigation of language as a potential factor in aviation accidents and incidents;
- the involvement of specialists in applied linguistics in accident investigations when language proficiency or language use is suspected as a causal factor;
- the development of an accurate and linguistically precise method for transcribing pilot-ATC discourse by means of real-life recordings with a view to establish a corpus of pilot-ATC recordings for review and research;
- an investigation into remedial training for pilots and ATCs who do not meet the requirements on an operational level; and
- the inclusion of cross-cultural and language awareness training for pilots, cabin crew members and ATCs in international operations.

Matthews (2012: 42) wrote that a review of the transcript of the exchange between the pilot and the ATC in the 2006 collision of a Boeing 737-800 and an Embracer Legacy 600 over the Amazon, revealed a number of “subtle linguistic phenomena” and she argues that accident investigators should be more aware of the role of language as a human factor in aviation. Matthews postulates that careful linguistic analyses can illuminate an area affecting flight safety, but unfortunately too often remain obscure in accident investigations. One of the elements she emphasises is the “chilling effects of inadequate early communication on subsequent communication” between pilots and ATCs due to the phenomenon that when native English speakers are confronted with communication difficulties with non-native English speakers, the native English speakers quit, withdraw or do not attempt to

continue with this difficult communication. Withdrawal occurs more frequently when native speakers perceive that “the non-native English speaker’s limited proficiency caused a failure in the execution of his or her job responsibilities” (Matthews, 2012:43). Research suggests that this type of response is a normal human reaction to communication difficulties.

Early communication failures turned out to be very important to the Amazon accident investigation because they provided evidence of a lack of awareness of ICAO language requirements (specifically regarding the use of standard phraseology); the importance of appropriate communication strategies to exchange messages and to recognise and resolve misunderstandings. These early communication failures also provided insight into why the pilots did not succeed to proactively initiate and maintain communication with the ATC.

Subtle linguistic clues will definitely assist us in understanding pilot-ATC communication problems and according to Matthews (2102), aviation accident investigators and human factor specialists (even those who specialise in communication) in general do not have the expertise to consider the subtle role that language may play in aviation communication and they do not have access to standardised tools to enable them to uncover language proficiency problems.

“If the link between language proficiency and safety is not made explicit, then the industry will continue to misunderstand the critical need for language training to become a priority and a long-term, industry wide commitment” (Matthews, 2012: 46). The assistance of trained linguists could well prove to be an invaluable asset in preventing aviation accidents where language-related communication problems occurred.

Finally, I hope that this study will first of all increase pilots’ and ATCs’ awareness of the role of language in aviation safety, and will, secondly, encourage aviation administrators and regulators to undertake research on the highly relevant and complex phenomenon of Aviation English and its use in real-life communication.

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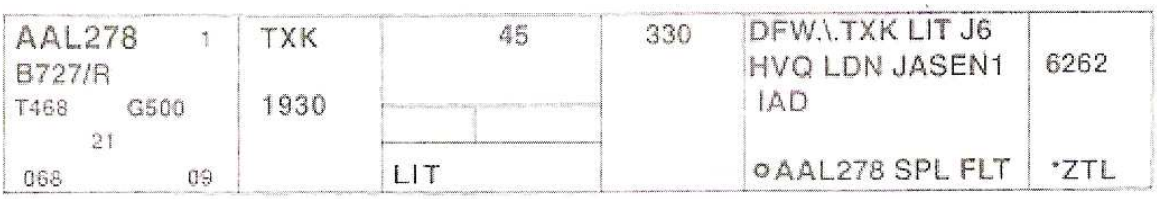
For definition of “QNH”:
http://en.wikipedia.org/wiki/QNH

Appendix A Example of a flight progress strip used by ATCs



The various components of a flight progress strip include information like the aircraft call-sign, the type of aircraft, true airspeed, groundspeed, sector number, strip number, and scheduled altitude. ATCs use flight progress strips to keep track of the different aircraft moving through the controlled airspace at the airport.

Appendix B The LPR Test Report CA61.01.7 (2012)

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division: **LICENSING** Form Number: CA 61-01.07
Telephone number: 011-545-1000 Fax Number: 011-545-1459
Physical address: Ikhaya Lokundiza, 16 Treur Close, Waterfall Park, Bekker Street, Midrand, Gauteng
Postal address: Private Bag X73, Halfway House 1686 Website: www.caa.co.za

DETAILS OF BANK ACCOUNT FOR PAYMENT OF PRESCRIBED FEE			
Bank: Standard Bank of SA Ltd	Branch: Brooklyn, Pretoria	Branch Code: 011245	Account Number: 013007871

COMPULSORY CLIENT PAYMENT CODE (to be completed on deposit slip)

Service/transaction	Over the counter payments	EFT, Internet, Wire, Electronic payments
Language proficiency test report		

LANGUAGE PROFICIENCY TEST REPORT FOR RADIOTELEPHONY COMMUNICATION

PART 1: PERSONAL DETAILS							
CANDIDATE							
Name in block letters							
RSA ID							
E-mail address							
Telephone number		Cellular phone number					
Licence Number							
Capacity:	Pilot		Air Traffic Services Personnel		Radio Station Operator		
LANGUAGE BACKGROUND							
Nationality							
Native English speaking Country (e.g. Australia, USA,NZ, Ireland							
Non Native Country with English as a second language (.g. India, Malaysia, Singapore, Philippines)							
Country with English as a Foreign Language (e.g. China, Germany, Japan, Paraguay)							
CURRENT EMPLOYMENT – Number of years of service with existing employer (for foreign nationals only)							
Less than 1 year		Between 1 to 3 years		More than 3 years			
EDUCATIONAL BACKGROUND *(Tick as applicable below and attach a copy of the relevant certificate)*							
High School		Vocational		Diploma		Undergraduate		Postgraduate	

	Certificates	Name of School/Institute	Country
	GCE "O" Level (Minimum credit in English) or its equivalent:		
	GCE "A" Level or its equivalent:		
	International Baccalaureate with English as the medium of instruction		
	University Degree with English as the medium of instruction (excludes distance education)		
	IELTS – Minimum Band 7 (out of 9)		
	TOEFL – Minimum Score: Computer based – 250, Paper Version – 600		
	South African Grade 12/Matric Certificate with English First or Second Language – (Minimum credit in English)		
	Others (e.g language proficiency certification from a foreign CAA in accordance with ICAO language rating scale)		

TRAINING DURING THE LAST 3 YEARS		
Course Name	Place	Duration

PROFESSIONAL BACKGROUND		
Period of Service	Employer	Position Title

ANY OTHER RELEVANT INFORMATION

DECLARATION BY APPLICANT		
I declare that the information provided above is true to the best of my knowledge. I have attached as evidence a copy of the certificate(s) that I have ticked as applicable above.		
SIGNATURE OF APPLICANT	NAME IN BLOCK LETTERS	DATE

PART 2 Section 1: REPORTING ON RATING						
PROFICIENCY TEST DETAILS						
Initial				Revalidation		
Place						
ICAO LANGUAGE PROFICIENCY RATING SCALE		Overall Test Result	Duration of Validity	Date of Test	Expiration Date of Rating	
Expert	Level 6		Permanent		Does not expire	
Extended	Level 5		6 years			
Operational	Level 4		3 years			
Pre-Operational	Level 3		Not yet competent. Recommended that applicant should attend a English language course prior to re-testing (Re-test in not less than 90 days)			
Elementary	Level 2					
Preliminary	Level 1					

Level of Proficiency rated in each Area of Linguistic Description					
Pronunciation	Structure	Vocabulary	Fluency	Comprehension	Interactions

TEST CENTRE AND ASSESSOR DETAILS			
Name of Test Centre			
Accreditation Number			
Telephone number		Fax number	
Cellular phone number		E-mail address	
Name of Linguistic Expert			
Accreditation Number			
SIGNATURE OF LINGUISTIC EXPERT	**NAME IN BLOCK LETTERS**	**DATE**	
Telephone number		Fax number	
Cellular phone number		E-mail address	
Name of Subject Matter Expert			
Accreditation Number			
SIGNATURE OF SUBJECT MATTER EXPERT	**NAME IN BLOCK LETTERS**	**DATE**	
Telephone number		Fax number	
Cellular phone number		E-mail address	

REQUIREMENTS FOR PROFICIENCY IN AVIATION LANGUAGES USED FOR RADIOTELEPHONY COMMUNICATIONS

International Accident Reports revealed that aircraft accidents are caused due to aircrew not being proficient in a particular language.

The International Civil Aviation Organisation (ICAO) therefore decided that by 5 March 2008 all applicants for a pilots licences, all current pilot licence holders, Air Traffic Services Personnel and Station Operators Licences shall demonstrate, in a manner acceptable to the licensing authority, the ability to speak and understand the English language used for radiotelephony communications in compliance with the holistic descriptions contained in the ICAO Operational level (level 4) of the ICAO Language Profiency Rating Scale.

APPLICATION OF LANGUAGE PROFICIENCY STANDARDS TO EXISTING LICENSE HOLDERS

1. All Air Traffic Services Personnel and Aeronautical Station Operators, i.e. existing and new license holders have to meet the "speak and understand" Standard.
2. All holders of an aeroplane and helicopter pilot license issued after 5 March 2004 have to meet the "speak and understand" Standards.
3. Holders of an aeroplane and helicopter pilot license issued before 5 March 2004 do not have to meet the "speak and understand" Standard until 5 March 2008. Therefore, on this date, they will have not only to meet the Standard but they will have to be assessed in accordance with the rating scale.

APPLICATION TO DOMESTIC FLIGHT

The language proficiency Standards is ICAO Standards and as such they only apply to pilots who are engaged in international flights and ATCO/ASO providing services to international flights.

CONSEQUENCES OF NON-COMPLIANCE WITH THE LANGUAGE PROFICIENCY STANDARDS

For pilots: Article 33 of the Chicago Convention makes the international recognition of a flight crew license conditional to full compliance with all relevant ICAO Standards including language proficiency. As a result, a pilot that does not meet the language requirements will only be able to fly internationally with the authorization of each of the States whose airspace is used. States would certainly be reluctant to give such an authorization and for practical purposes pilots will have to meet the language requirements to fly internationally. That does not necessarily mean that flight crew have to meet the language proficiency in English to fly internationally. For instance, you can fly in most of South and Central America speaking only Spanish but in such a case, you have to demonstrate language proficiency in Spanish. Therefore, English proficiency remains a requirement for most of the international flights, as it is the only language available on a worldwide basis for the provision of air traffic services.

For Air Traffic Services Personnel and Aeronautical Station Operators: If an Air Traffic Services Personnel or Aeronautical Station Operator providing service to international flights does not meet the language proficiency Standard; the State will have to notify a difference. Any person or operator flying into that State's airspace will have to assess the situation and decide whether they want to continue that operation in view of the safety and resulting liability aspects.

Proficient pilot speakers shall:

1. Communicate effectively in voice-only (telephone/radiotelephone) and in face-to-face situations;
2. Communicate on common, concrete and work-related topics with accuracy and clarity;
3. Use appropriate communicative strategies to exchange messages and to recognize and resolve misunderstandings (e.g. to check, confirm or clarify information) in a general or work-related context;
4. Handle successfully and with relative ease the linguistic challenges presented by a complication or unexpected turn of events that occurs within the context of a routine work situation or communicative task with which they are otherwise familiar; and Use a dialect or accent which is intelligible to the aeronautical community.

PART 2: Section 2: ICAO ENGLISH PROFICIENCY RATING SCALE					
	Level 6	**Level 5**	**Level 4**	**Level 3**	**Level 2**
	EXPERT	**EXTENDED**	**OPERATIONAL**	**PRE-OPERATIONAL**	**ELEMENTARY**
Pronunciation ***Assumes a dialect and/or accent intelligible to the aeronautical community***	Pronunciation, stress, rhythm, and intonation though possibly influenced by the first language or regional variation, almost never interfere with ease of understanding.	Pronunciation, stress, rhythm, and intonation, though influenced by the first language or regional variation, rarely interfere with ease of understanding	Pronunciation, stress, rhythm, and intonation are influenced by the first language or regional variation but only sometimes interfere with ease of understanding.	Pronunciation, stress, rhythm, and intonation are influenced by the first language or regional variation and frequently interfere with	Pronunciation, stress, rhythm, and intonation are heavily influenced by the first language or regional variation and usually interfere with ease of understanding.
Structure ***Relevant grammatical structures and sentence patterns are determined by language functions appropriate to the task***	Both basic and complex grammatical structures and sentence patterns are consistently well controlled.	Basic grammatical structures and sentence patterns are consistently well controlled. Complex structures are attempted but with errors which sometimes interfere with meaning.	Basic grammatical structures and sentence patterns are used creatively and are usually well controlled. Errors may occur, particularly in unusual or unexpected circumstances, but rarely interfere with meaning.	Basic grammatical structures and sentence patterns associated with predictable situations are not always well controlled. Errors frequently interfere with meaning.	Shows only limited control of a few simple memorized grammatical structures and sentence patterns.
Vocabulary	Vocabulary range and accuracy are sufficient to communicate effectively on a wide range of familiar and unfamiliar topics. Vocabulary is idiomatic, nuanced, and sensitive to register.	Vocabulary range and accuracy are sufficient to communicate effectively on common, concrete, and work-related topics. Paraphrases consistently and successfully. Vocabulary is sometimes idiomatic.	Vocabulary range and accuracy are usually sufficient to communicate effectively on common, concrete, and work-related topics. Can often paraphrase successfully when lacking vocabulary in unusual or unexpected circumstances.	Vocabulary range and accuracy are often sufficient to communicate on common, concrete, or work-related topics, but range is limited and the word choice often inappropriate. Is often unable to paraphrase successfully when lacking vocabulary.	Limited vocabulary range consisting only of isolated words and memorized phrases.

SIGNATURE OF APPLICANT	NAME IN BLOCK LETTERS	DATE
SIGNATURE OF LINGUISTIC EXPERT	NAME IN BLOCK LETTERS	DATE
SIGNATURE OF SUBJECT MATTER EXPERT	NAME IN BLOCK LETTERS	DATE

Fluency	Able to speak at length with a natural, effortless flow. Varies speech flow for stylistic effect, e.g. to emphasize a point. Uses appropriate discourse markers and connectors spontaneously.	Able to speak at length with relative ease on familiar topics but may not vary speech flow as a stylistic device. Can make use of appropriate discourse markers or connectors.	Produces stretches of language at an appropriate tempo. There may be occasional loss of fluency on transition from rehearsed or formulaic speech to spontaneous inter-action, but this does not prevent effective communication. Can make limited use of discourse markers or connectors. Fillers are not distracting.	Produces stretches of language, but phrasing and pausing are often inappropriate. Hesitations or slowness in language processing may prevent effective communication. Fillers are sometimes distracting.	Can produce very short, isolated, memorized utterances with frequent pausing and a distracting use of fillers to search for expressions and to articulate less familiar words.
Comprehension	Comprehension is consistently accurate in nearly all contexts and includes comprehension of linguistic and cultural subtleties.	Comprehension is accurate on common, concrete and work-related topics and mostly accurate when the speaker is confronted with a linguistic or situational complication or an unexpected turn of events. Is able to comprehend a range of speech varieties (dialect and/or accent) or registers.	Comprehension is mostly accurate on common, concrete and work-related topics when the accent or variety used is sufficiently intelligible for an international community of users. When a speaker is confronted with a linguistic or situational complication or an unexpected turn of events, comprehension may be slower or require clarification strategies.	Comprehension is often accurate on common, concrete, and work-related topics when the accent or variety used is sufficiently intelligible for an international community of users. May fail to understand a linguistic or situational complication or an unexpected turn of events.	Comprehension is limited to isolated, memorized phrases when they are carefully and slowly articulated.
Interaction	Interacts with ease in nearly all situations. Is sensitive to verbal and non-verbal cues and responds to them appropriately.	Responses are immediate, appropriate, and informative. Manages the speaker/listener relationship effectively	Responses are usually immediate, appropriate, and informative. Initiates and maintains exchanges even when dealing with an unexpected turn of events. Deals adequately with apparent misunderstandings by checking, confirming or clarifying.	Responses are sometimes immediate, appropriate, and informative. Can initiate and maintain exchanges with reasonable ease on familiar topics and in predictable situations. Generally inadequate when dealing with an unexpected turn of events.	Response time is slow and often inappropriate. Interaction is limited to simple routine exchanges.

SIGNATURE OF APPLICANT	NAME IN BLOCK LETTERS	DATE
SIGNATURE OF LINGUISTIC EXPERT	NAME IN BLOCK LETTERS	DATE
SIGNATURE OF SUBJECT MATTER EXPERT	NAME IN BLOCK LETTERS	DATE

PART 3: FEEDBACK SECTION	
PRONUNCIATION	
Weaknesses	
Recommendation	
STRUCTURE	
Weaknesses	
Recommendation	
VOCABULARY	
Weaknesses	
Recommendation	
FLUENCY	
Weaknesses	
Recommendation	
COMPREHENSION	
Weaknesses	
Recommendation	
INTERACTION	
Weaknesses	
Recommendation	

SIGNATURE OF APPLICANT	**NAME IN BLOCK LETTERS**	**DATE**
SIGNATURE OF LINGUISTIC EXPERT	**NAME IN BLOCK LETTERS**	**DATE**
SIGNATURE OF SUBJECT MATTER EXPERT	**NAME IN BLOCK LETTERS**	**DATE**

Appendix C Questionnaire

survey.pilots.co.za

Research questionnaire

Dear Pilot/Air Traffic Controller

- This questionnaire will take less than 10 minutes to complete by just clicking the correct answers.
- The information is anonymous and confidential and participation is voluntary.
- The questionnaire consists of three sections: aviation, bio-demographic, and language and communication.

Purpose of the study

This study aims to investigate the use of English as the shared language among pilots and ATCs, as well as the nature of communication in air traffic control in South Africa. [More details]

The link [More details] contained the following information:

Salome Coertze (Researcher)
english@pilots.co.za
Master's degree in Linguistics
Supervisors: Drs Simone Conradie and Kate Huddlestone
Department of General Linguistics
Faculty of Arts and Social Sciences
Stellenbosch University

If you would like to receive the results of this research project, please provide an email address*.

*** Email addresses will not be used to identify respondents or for any other reason, but will only be used for providing the results of the research project.**

Consent and permission

1. I grant permission that the information I provide below be used for research purposes, which will not be in any way be to my disadvantage or detriment:

   Yes ◎ No ◎

2. I understand that the information I provide is confidential and for the purpose of this research project only and that I participate anonymously. I also confirm having participated under informed consent.

   Yes ◎ No ◎

Please select your location:

South Africa ◎ Southern Africa ◎ Other ◎

What is your main/primary/activity/occupation in aviation?

Pilot ◎ Air Traffic Controller (ATC) ◎

Continue

This survey is hosted in the interest of aviation safety by Superb Flight Training and The Aviation Training Booking System.

Section 1 (Pilots)

Aviation

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1. Which category best describes your flying career?

Student pilot

Private pilot (leisure/hobby/business)

Part-time professional pilot

Full-time professional pilot

2. Which category includes your total of flying hours?

Less than 200

200-1 000

1 000-5 000

More than 5 000

3. Indicate your highest completed flying qualification. (Choose all applicable)

Student pilot

PPL/MPL/NPL

CPL

ATPL

4. Indicate the aircraft on which you received or still receive flight training. (Choose all applicable)

Aeroplane

Helicopter

Other (Gyrocpter/Trike/Glider)

5. Do you have an instrument rating?

No

Single-engine

Multi-engine

6. Do you have an instructor rating?

No

Microlight or NPL

Grade III

Grade II

Grade I

7. Which of the following types and classes of aircraft do you fly at least once a month? (Choose all applicable)

Aeroplanes:

Single-engine piston

Multi-engine piston

Turboprop

Jet

Other:

Helicopter

Gyrocopter/Trike/Glider

8. How many flights do you typically fly each month?

Less than 4

4-12

13-20

More than 20

9. How often do you do flights beyond South African borders?

Never

At least once a year

At least once a month

At least once a week

Section 1 (ATCs)

Aviation

---

1. What is your highest qualification in Air Traffic Control?

ATC assistant

Tower

Approach

Area

2. How long have you been working as an ATC?

Less than two years

Two to five years

Five to 10 years

More than 10 years

3. What is your current function in ATC?

Assistant, briefing, management

Tower controller

Approach controller

Area controller

4. Do you work in an air traffic services unit that handles international air traffic?

Yes

No

Section 2 (Pilots and ATCs)

Bio-demographic

---

1. How old are you?

Younger than 29

30-39

40-49

50-59

Older than 60

2. What is your highest level of education apart from aviation qualifications?

Gr 12

Diploma/Certificate

Bachelor degree

Master's degree

Doctoral degree

3. In what language did you undergo most of your education?

English

Other official SA language (please state)

Other (please state)

4. Which language is your mother tongue (first language)?

English

Other official SA language (please state)

Other (please state)

5. In which province do you live?

Eastern Cape

Free State

Gauteng

Kwazulu-Natal

Limpopo

Mpumalanga

Northern Cape

North West

Western Cape

Section 3 (Pilots and ATCs)

Language and Communication

1. How many times have you experienced radio communication problems while flying/doing air traffic control?

Never

1-3

3-10

More than 10

2. How many times have you been in threatening situations while flying/doing traffic control, where communication problems contributed to the situation?

Never

1-3

3-10

More than 10

I don't understand the question

3. How confident are you that problems in communication among pilots and ATCs in South Africa are resolved quickly and easily in order to avoid accidents?

Not confident

Fairly confident

Confident

Very confident

4. In your opinion, which category is most often the cause for communication problems among pilots and ATCs? (Choose all applicable)

Non-language-related factors:

Attitude

Non-compliance with instructions

Nervousness

Lack of experience

Language-related factors:

Pronunciation

Structure

Vocabulary

Fluency

Comprehension

Interaction

Other factors:

Radio distortion and background noise

Radio malfunction

Frequency congestion

5. Do you think it is possible that language-related communication problems among pilots and ATCs can cause fatal accidents and serious incidents?

Impossible

Unlikely

Possible

Likely

I don't understand the question

6. Do you support English Language Proficiency standards and testing among pilots and ATCs in South Africa?

Strongly oppose

Somewhat oppose

Neutral

Somewhat in favour

Strongly in favour

7. Do you agree with the use of English as the common language in a multilingual aviation community nationally and internationally?

Disagree

Neutral

Agree

I don't understand the question

8. In general, how would you rate the English Language Proficiency standard of pilots and ATCs in South Africa?

Poor

Adequate

Good

Excellent

Thank you for your contribution!

End of the questionnaire

Appendix D Worksheet: Analysis of recordings of pilot-ATC communication

Airport X – 07:00-12:00 (approximately 5 hours)

1	Read-back errors/Hear-back errors (type of information)	
2	No read-back	
3	Requests for repeats	
4	Call-sign discrepancies/similar call-signs	
5	Loss of communication	
6	Equipment malfunction	
7	Radio interference/distortion & background noise	
8	Deviations from Aviation English/non-standard phraseology	
9	Pronunciation (Accent)	
10	Comprehension	
11	Attitude	
12	Frequency congestion	